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Porphyry. lefs with pale red and white; its purple is of all degrees, from the claret-colour to that of the violet; and its variegations are rarely difpofed in veins, but fpots, fometimes very fmall, and at others running into large blotches. It is lefs fine than many of the ordinary marbles; but it excels them all in hardnefs, and is capable of a moft elegant polifh. It is ftill found in immenfe ftrata in Egypt. The hard red-lead coloured porphyry, variegated with black, white, and green, is a moft beautiful and valuable fubftance. It has the hardnefs and all the other characters of the oriental porphyry; and even greatly excels it in brightnefs, and in the beauty and variegation of its colours. It is found in great plenty in the ifland of Minorca; and is well worth importing, being greatly fuperior to all the Italian marbles. The hard, pale-red porphyry, variegated with black, white, and green, is of a pale flefh-colour; often approaching to white. It is variegated in blotches from half an inch to an inch broad. It takes a high polifh, and emulates all the qualities of the oriental porphyry. It is found in immenfe ftrata in Arabia Petræa, and in the Upper Egypt; and in feparate nodules in Germany, England, and Ireland.

Ficoroni takes notice of two exquifitely fine columns of black porphyry in a church at Rome. In Egypt there are three celebrated obelifks or pillars of porphyry, one near Cairo and two at Alexandria. The French call them *aguglias*, and in England they are called *Cleopatra's needles*.

The art of cutting porphyry, practifed by the ancients, appears now to be loft. Indeed it is difficult to conceive what tools they ufed for faftioning thofe huge columns and other porphyry works in fome of the ancient buildings in Rome. One of the moft confiderable of thefe, ftill entire, is a tomb of Conftantia, the emperor Conftantine's daughter. It is in the church of St Agnes, and is commonly called *the tomb of Bacchus*. In the palace of the Thuilleries there is alfo a buft of Apollo and of twelve emperors, all in porphyry. Some ancient pieces feem to have been wrought with the chifel, others with the faw, others with wheels, and others gradually ground down with emery. Yet modern tools will fcarce touch porphyry. Dr Lifter therefore thinks*, that the ancients had the fecret of tempering fteel better than we; and not, as fome imagine, that they had the art of foftening the porphyry; though it is probable that time and air have contributed to increafe its hardnefs. Mr Addifon fays, he faw a workman at Rome cutting porphyry; but his advances were extremely flow and almoft infenfible. The Italian fculptors work the pieces of old porphyry columns ftill remaining (for the porphyry quarries are long fince loft) with a brafs faw without teeth. With this faw, emery, and water, they rub and wear the ftone with infinite patience. Many perfons have endeavoured to retrieve the ancient art, and particularly Leon Baptifta Alberti; who, fearching for the neceffary materials for temper, fays, he found goats blood the beft of any: but even this availed not much; for in working with chiffels tempered with it, fparks of fire came much more plentifully than pieces of the ftone. The fculptors were thus, however, able to make a flat or oval form; but could never attain to any thing like a figure.

In the year 1555, Cofmo de Medicis is faid to have diftilled a water from certain herbs, with which his fculptor Francefco Tadda gave his tools fuch an admirable hardnefs and fo fine a temper, that he performed fome very exquifite works with them; particularly our Saviour's head in demi-relievo, and Cofmo's head and his ducheſs's. The very hair and beard, how difficult fo-ever, are here well conducted; and there is nothing of the kind fuperior to it in all the works of the ancients; but the fecret appears to have died with him. The French have difcovered another mode of cutting porphyry, *viz.* with an iron faw without teeth, and *grez*, a kind of free ftone pulverized, and water. The authors of this invention fay, that they could form the whole contour of a column hereby if they had matter to work on. Others have propofed to harden tools fo as to cut porphyry, by fteeping them in the juice of the plant called *bear's beech* or *brankurfine*. See Birch's *Hift.* R. S. vol. i. p. 238. vol. ii. p. 73, &c. Mr Boyle fays, that he caufed porphyry to be cut by means of emery, fteel faws, and water; and obferves, that in his time the Engliſh workmen were ignorant of the manner of working porphyry, and that none of them would undertake to cut or polifh it. See his Works abr. vol. i. p. 111.

Da Coſta fuppofes, and perhaps with reafon, that the method ufed by the ancients in cutting and engraving porphyry was extremely fimple, and that it was performed without the aid of any fcientific means that are now loft. He imagines, that, by unwearied diligence, and with numbers of common tools at great expence, they rudely hewed or broke the ftone into the intended figure, and by continued application reduced them into more regular defigns; and that they completed the work by polifhing it with great labour, by the aid of particular hard fands found in Egypt. And he thinks, that in the porphyry quarries there were layers of grit or loofe difunited particles, analogous to the porphyry, which they carefully fought for, and ufed for this work. See *Nat. Hift. of Foffils*, p. 285.

Porphyry-Shell, a fpecies of Murex.

PORPITES, the Hair-button stone, in natural hiftory, a name given by authors to a fmall fpecies of foffil coral; which is ufually of a rounded figure confiderably flatted, and ftriated from the centre everyway to the circumference. Thefe are of different fizes and of different colours, as greyifh, whitifh, browniſh, or bluifh, and are ufually found immerfed in ftone. See Plate CC.

PORRUM, the Leek; a fpecies of plants, belonging to the genus of Allium.

PORT, a harbour, river, or haven, formed either by nature or art to receive and fhelter fhipping from the ftorms and waves of the open fea.

Artificial ports are thofe which are either formed by throwing a ftrong mound or rampire acrofs the harbour's mouth to fome ifland or rock, or erecting two long barriers, which ftretch from the land on each fide like arms or the horns of a creſcent, and nearly inclofe the haven; the former of thefe are called *mole-heads* and the latter *piers*.

Port, is alfo a name given on fome occafions to the larboard or left fide of the fhip, as in the following inftances. Thus it is faid, "the fhip heels to port," *i. e.* ftoops or inclines to the larboard-fide. "Top the yard to port!" the order to make the larboard extremity of a yard higher than the other. "Port the helm!" the

Porphyry || Port.

* *Philoſoph. Tranſact.* N° 203. or *Lowth's Abrid.* vol. ii. p. 560.

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Port. order to put the helm over to the larboard-ſide of the veſſel. In all theſe ſenſes this phraſe appears intended to prevent any miſtakes happening from the ſimilarity of ſounds in the words *ſtarboard* and *larboard*, particularly when they relate to the helm, where a miſapprehenſion might be attended with very dangerous conſequences.

PORTS, the embraſures or openings in the ſide of a ſhip of war, wherein the artillery is ranged in battery upon the decks above and below.

The ports are formed of a ſufficient extent to point and fire the cannon, without injuring the ſhip's ſide by the recoil; and as it ſerves no end to enlarge them beyond what is neceſſary for that purpoſe, the ſhipwrights have eſtabliſhed certain dimenſions, by which they are cut in proportion to the ſize of the cannon.

The ports are ſhut in at ſea by a ſort of hanging-doors called the *port-lids*; which are faſtened by hinges to their upper edges, ſo as to let down when the cannon are drawn into the ſhip. By this means the water is prevented from entering the lower decks in a turbulent ſea. The lower and upper edges of the ports are always parallel to the deck, ſo that the guns, when levelled in their carriages, are all equally high above the lower extremity of the ports, which is called the *port-ſells*.

PORT, is alſo a ſtrong wine brought from Port-a-port, and alſo called *Porto* and *Oporto*.

PORT of the Voice, in muſic, the faculty or habit of making the ſhakes, paſſages, and diminutions, in which the beauty of a ſong or piece of muſic conſiſts.

PORT-Crayon, a pencil-caſe, which is uſually four or five inches long, and contrived ſo as that the pencil may ſlide up and down. Its inſide is round, and its outſide is ſometimes filed into eight ſides or faces, on which are drawn the ſector-lines; ſometimes it is made round both without-ſide and within, and has its length divided into inches and parts of inches.

PORT-Fire, a compoſition for ſetting fire to powder, &c. Port-fires are frequently uſed by artillery people in preference to matches; and they are diſtinguiſhed into wet and dry port-fires. The compoſition of the former is ſaltpetre four, ſulphur one, and mealed powder four. When theſe materials are thoroughly mixed and ſifted, the whole is to be moiſtened with a little linſeed oil, and rubbed between the hands till all the oil is imbibed by the compoſition. The preparation for dry port-fires is ſaltpetre four, ſulphur one, mealed powder two, and antimony one. Theſe compoſitions are driven into ſmall paper caſes, to be uſed whenever neceſſary.

PORT-aux-Prune, ſo called by the French, is a country on the coaſt of Africa, to the north of the iſland of Madagaſcar. It is a rich country, and fertile in rice and paſtures; it is inhabited only by the negroes, who are an induſtrious good ſort of people, but very ſuperſtitious. There are no towns, but ſeveral villages, and they have ſome cuſtoms which ſeem to incline to Judaiſm.

PORT-Jackſon, in New Holland. See *New HOLLAND*, n° 7, &c.

PORT-Royal, a ſea-port town in the iſland of Jamaica. It was once a place of the greateſt riches and importance in the Weſt Indies: but in 1692 it was deſtroyed by an earthquake, in 1702 by fire, in 1722 by an inundation of the ſea, and in 1744 it ſuffered greatly by a hurricane. It is now reduced to three ſtreets, a few lanes, and about 200 houſes. It contains the royal navy-yard for heaving down and refitting the king's ſhips; the navy-hoſpital, and barracks for a regiment of ſoldiers. The fortifications, which are very extenſive, being in excellent order, and having been lately ſtrengthened with many additional works, it may be ſaid to vie in point of ſtrength with any fortreſs in the king's dominions. The harbour is one of the beſt in the world, and 1000 ſhips may ride therein, ſecure from every wind that can blow. It is ſix miles eaſt of Spaniſh-town, and as much by water ſouth-eaſt of Kingſton. W. Long. 76. 40. N. Lat. 18. 0. Port || Porter.

PORT-Royal, an iſland in North America, on the coaſt of South Carolina, which, with the neighbouring continent, forms one of the moſt commodious harbours in the Britiſh plantations. It is 15 miles in length; and the town on the north ſhore is called *Beaufort*. W. Long. 80. 10. N. Lat. 31. 40.

PORT-Royal, the name of two monaſteries of Ciſtertian nuns in the dioceſe of Paris; the one near Chevreuſe, at the diſtance of five leagues from Paris, called *Port-Royal of the Fields*; and the other in Paris, in the ſuburbs of St James.

The nuns of the former of theſe monaſteries proving refractory, were diſperſed; when many eccleſiaſtics, and others, who were of the ſame ſentiments as theſe religious, retired to Port-Royal, took apartments there, and printed many books. Hence the name of *Port-Royaliſts* was given to all their party, and their books were called *books of Port-Royal*: from hence we ſay the writers of Port-Royal, Meſſieurs de Port-Royal, and the tranſlations and grammars of Port-Royal.

PORTA, or *Vena PORTA*, in anatomy, a large vein diſtributed through the liver in the manner of an artery. See ANATOMY, n° 96.

PORTA-Anguſta (anc. geog.), mentioned only by Ptolemy; a town of the Vaccæi in the Hither Spain; thought by ſome to be *Torre Quemada*, in Old Caſtile; by others *Los Valvaſes*, a village between Burgos and Torre Quemada.

PORTÆ-ROMANÆ (anc. geog.), according to Pliny, Romulus left but three, or at moſt four, gates of Rome: afterwards, on enlarging the Pomœria, or compaſs of the city, they amounted to 37.

PORTAL, in architecture, a little gate where there are two gates of a different bigneſs; alſo a little ſquare corner of a room cut off from the reſt by the wainſcot, and forming a ſhort paſſage into the room. The ſame name is alſo ſometimes given to a kind of arch of joiners work before a door.

PORTATE, or a *Croſs PORTATE*, in heraldry, a croſs which does not ſtand upright, as croſſes generally do; but lies acroſs the eſcutcheon in bend, as if it were carried on a man's ſhoulder.

PORTCULLICE, in fortification, is an aſſemblage of ſeveral large pieces of wood, joined acroſs one another like a harrow, and each pointed with iron at the bottom. They are ſometimes hung over the gate-way of old fortified towns, ready to let down in caſe of ſurpriſe, when the gates could not be ſhut.

PORTER, a kind of malt-liquor which differs from ale and pale beer, in its being made with high dried malt. See ALE, BEER, and BREWING.

PORT-

Port-Glaſgow || Portico.

PORT-GLASGOW. See GLASGOW, n° 10.

PORTGREVE, or PORTGRAVE, was anciently the principal magiſtrate in ports and other maritime towns. The word is formed from the Saxon *port*, "a port or other town;" and *geref*, "a governor."—It is ſometimes alſo written *port-reve*.

Camden obſerves, that the chief magiſtrate of London was anciently called *port-greve*: inſtead of whom, Richard I. ordained two bailiffs; and ſoon afterwards King John granted them a mayor for their yearly magiſtrate.

PORTICI, a palace of the king of Naples, ſix miles from that capital. It has a charming ſituation, on the ſea-ſide, near mount Veſuvius. It is enriched with a vaſt number of fine ſtatues, and other remains of antiquity, taken out of the ruins of Herculaneum.

The muſeum conſiſts of 16 rooms, in which the different articles are arranged with very great taſte. The floors are paved with Moſaic, taken from the recovered towns, and the walls of the court are lined with inſcriptions. Beſides buſts, ſtatues, medals, intaglios, lamps, and tripods, there is ſcarcely an article uſed by the ancients of which a ſpecimen may not be ſeen in this muſeum. "But the moſt valuable room is the library, from the numerous manuſcript rolls which it contains. What a field is here for conjecture! what room for hope! Among this ineſtimable collection, how many great works are there, of which even the names are now unknown! how many unbroken volumes, whoſe very fragments, preſerved in the writings of the ancient ſcholiaſts, convey to us moral improvement, information, and delight! perhaps all the dramatic pieces of Menander and Philemon; perhaps, nay, certainly, the loſt Decades of Livy; for it is impoſſible to ſuppoſe, that among ſo many rolls, the moſt admired hiſtory of the people who poſſeſſed them is not to be found: what private library in Britain is without the beſt hiſtories of England? But how I tremble for their ſituation, as Portici is built on the lava that overwhelmed Herculaneum! How I tremble too for the indifference of the king of Naples towards this invaluable treaſure, in which all the moſt enlightened people of Europe are deeply intereſted! When I firſt ſaw them, I had no idea of what they were, as they reſemble wooden truncheons burnt almoſt to charcoal. They are ſo hard and brittle, that the greateſt caution muſt be uſed in removing them, leſt they crumble to duſt; nevertheleſs, an ingenious friar of Genoa, named *Raggio*, undertook to unroll them; and by a moſt curious, though tedious proceſs, ſo far ſucceeded, as to tranſcribe three Greek Treatiſes on Philoſophy and Muſic; but finding (as I hear) no other encouragment than his ſalary, which was but little more than you pay ſome of your ſervants, the work was unhappily diſcontinued. Were theſe manuſcripts in England, they would not long remain a ſecret to the world."

Watkins's Travels through Switzerland, Italy, &c.

PORTICO, in architecture, a kind of gallery on the ground; or a piazza encompaſſed with arches ſupported by columns, where people walk under covert. The roof is uſually vaulted, ſometimes flat. The ancients called it *lacunar*. Though the word *portico* be derived from *porta*, "gate, door;" yet it is applied to any diſpoſition of columns which form a gallery, without any immediate relation to doors or gates. The moſt celebrated porticoes of antiquity were, thoſe of Solomon's temple, which formed the atrium or court, and encompaſſed the ſanctuary; that of Athens, built for the people to divert themſelves in, and wherein the philoſophers held their diſputes and converſations, (ſee PORCH); and that of Pompey at Rome, raiſed merely for magnificence, conſiſting of ſeveral rows of columns ſupporting a platform of vaſt extent; a draught whereof, Serlio gives us in his antique buildings. Among the modern porticoes, the moſt celebrated is the piazza of St Peter of the Vatican.—That of Covent-Garden, London, the work of Inigo Jones, is alſo much admired.

Portii, Portland.

PORTII. See POMPEII.

PORTLAND, a peninſula in Dorſetſhire, of great ſtrength both by nature and art, being ſurrounded with inacceſſible rocks, except at the landing-place, where there is a ſtrong caſtle, called *Portland caſtle*, built by king Henry VIII. There is but one church in the iſland: and that ſtands ſo near the ſea, that it is often in danger from it. It is now chiefly noted for the free-ſtone which is found there, and which is greatly employed in London, and other parts of England, for building the fineſt ſtructures. St Paul's church, in particular, was built therewith. W. Long. 2. 35. N. Lat. 50. 30.

The following cuſtom at Portland is worthy of notice. "While I was looking over the quarries at Portland (ſays Mr Smeaton), and attentively conſidering the operations, obſerving how ſoon the quarrymen would cut half a ton of ſpawls from an unformed block, and what large pieces flew off at every ſtroke; how ſpeedily their blows followed one another, and how inceſſantly they purſued this labour with a tool of from 18 to 20 pound weight; I was naturally led to view and conſider the figure of the operative agent; and after having obſerved, that by far the greateſt number of the quarrymen were of a very robuſt hardy form, in whoſe hands the tool I have mentioned ſeemed a mere play-thing, I at laſt broke out with ſurpriſe, and inquired of my guide, Mr Roper, where they could poſſibly pick up ſuch a ſet of ſtout fellows to handle the *level*, which in their hands ſeemed nothing? for I obſerved, that in the ſpace of 15 minutes, they would knock off as much waſte matter from a maſs of ſtone, as any of that occupation I had ever ſeen before would do in an hour. Says Roper, 'we do not go to fetch thoſe men from a diſtance, they are all born upon the iſland, and many of them have never been farther upon the main land than to Weymouth.' I told him, I thought the air of that iſland muſt be very propitious, to furniſh a breed of men ſo particularly formed for the buſineſs they followed. 'The air (he replied), though very ſharp from our elevated ſituation, is certainly very healthy to working men; yet if you knew how theſe men are produced, you would wonder the leſs; for all our marriages here are productive of children.' On deſiring an explanation how this happened, he proceeded: 'Our people here, as they are bred to hard labour, are very early in a condition to marry and provide for a family; they intermarry with one another, very rarely going to the main-land to ſeek a wife; and it has been the cuſtom of the iſland, from time immemorial, that they never marry till the woman is pregnant.' But pray (ſaid I) does not this ſubject you to a great number of baſtards? Have not your Portlanders the ſame kind of ficklenes

Portland. in their attachments that Engliſhmen are ſubject to? and, in conſequence, does not this produce many inconveniences? 'None at all (replies Roper), for previous to my arrival here, there was but one child on record of the pariſh regiſter that had been born a baſtard in the compaſs of 150 years. The mode of courtſhip here is, that a young woman never admits of the ſerious addreſſes of a young man, but on ſuppoſition of a thorough probation. When ſhe becomes with child, ſhe tells her mother, the mother tells her father, her father tells his father, and he tells his ſon, that it is then proper time to be married.' But ſuppoſe, Mr Roper, ſhe does not prove to be with child, what happens then? Do they live together without marriage? or, if they ſeparate, is not this ſuch an imputation upon her, as to prevent her getting another ſuitor? 'The caſe is thus managed (anſwered my friend), if the woman does not prove with child after a competent time of courtſhip, they conclude they are not deſtined by Providence for each other; they therefore ſeparate; and as it is an eſtabliſhed maxim, which the Portland women obſerve with great ſtrictneſs, never to admit a plurality of lovers at one time, their honour is noway tarniſhed: ſhe juſt as ſoon (after the affair is declared to be broke off) gets another ſuitor, as if ſhe had been left a widow, or that nothing had ever happened, but that ſhe had remained an immaculate virgin.' But pray, Sir, did nothing particular happen upon your men coming down from London? 'Yes (ſays he) our men were much ſtruck, and mightily pleaſed with the facility of the Portland ladies, and it was not long before ſeveral of the women proved with child; but the men being called upon to marry them, this part of the leſſon they were uninſtructed in; and on their refuſal, the Portland women aroſe to ſtone them out of the iſland; inſomuch, that thoſe few who did not chooſe to take their ſweethearts for *better or for worſe*, after ſo fair a trial, were in reality obliged to decamp; and on this occaſion ſome few baſtards were born: but ſince then matters have gone on according to the ancient cuſtom."

PORTLAND VASE, a celebrated funeral vaſe which was long in poſſeſſion of the Baberini family; but which was lately purchaſed for 1000 guineas by the Duke of Portland, from whom it has derived its preſent name. Its height is about ten inches, and its diameter where broadeſt ſix. There are a variety of figures upon it of moſt exquiſite workmanſhip, in bas relief of white opake glaſs, raiſed on a ground of deep blue glaſs, which appears black except when held againſt the light. It appears to have been the work of many years, and there are antiquarians who date its production ſeveral centuries before the Chriſtian era; ſince, as has been ſaid, ſculpture was declining in excellence in the time of Alexander the Great.

Reſpecting the purpoſe of this vaſe, and what the figures on it were meant to repreſent, there have been a variety of conjectures, which it is not our buſineſs to enumerate. We think with Dr Darwin* that it was not made for the aſhes of any particular perſon deceaſed; and therefore that the ſubject of its embelliſhments is not a private hiſtory, but of a general nature. But we are not ſure that he is right in conjecturing it to repreſent a part of the Eleuſinian myſteries; becauſe that conjecture depends on Warburton's explanation of the 6th book of the Æneid, which does not now command that reſpect which it did when it was firſt propoſed. We ſhall therefore give a ſhort account of the ſeveral figures, without noticing any of the theories or conjectures that have been made about them. Portland || Port-Louis.

** Loves of the Plants.*

In one compartment three exquiſite figures are placed on a ruined column, the capital of which is fallen, and lies at their feet among other diſjointed ſtones: they ſit under a tree on looſe piles of ſtone. The middle figure is a female in a reclining and dying attitude, with an inverted torch in her left hand, the elbow of which ſupports her as ſhe ſinks, while the right hand is raiſed and thrown over her drooping head. The figure on her right hand is a man, and that on the left a woman, both ſupporting themſelves on their arms, and apparently thinking intenſely. Their backs are to the dying figure, and their faces are turned to her, but without an attempt to aſſiſt her. On another compartment of the vaſe is a figure coming through a portal, and going down with great timidity into a darker region, where he is received by a beautiful female, who ſtretches forth her hand to help him: between her knees is a large and playful ſerpent. She ſits with her feet towards an aged figure, having one foot ſunk into the earth, and the other raiſed on a column, with his chin reſting on his hand. Above the female figure is a Cupid preceding the firſt figure, and beckoning him to advance. This firſt figure holds a cloke or garment, which he ſeems anxious to bring with him, but which adheres to the ſide of the portal through which he has paſſed. In this compartment there are two trees, one of which bends over the female figure and the other over the aged one. On the bottom of the vaſe there is another figure on a larger ſcale than the one we have already mentioned, but not ſo well finiſhed nor ſo elevated. This figure points with its finger to its mouth. The dreſs appears to be curious and cumberſome, and above there is the foliage of a tree. On the head of the figure there is a Phrygian cap: it is not eaſy to ſay whether this figure be male or female. On the handles of the vaſe are repreſented two aged heads with the ears of a quadruped, and from the middle of the forehead riſes a kind of tree without leaves: theſe figures are in all probability mere ornaments, and have no connection with the reſt of the figures, or the ſtory repreſented on the vaſe.

PORTLANDIA, in botany: A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking with thoſe of which the order is doubtful. The corolla is elevated and funnel-ſhaped; the antheræ are longitudinal; the capſule pentagonal, and retuſe at top; bilocular, and crowned with a pentaphyllous calyx.

There are two ſpecies, viz. the grandiflora and hexandra; the former of which has been particularly deſcribed by Dr Browne, who has alſo given a good figure of it. It has frequently flowered in the royal garden at Kew, and in Dr Pitcairn's at Iſlington.

The external bark is remarkably rough, furrowed, and thick; it has no taſte. The inner bark is very thin, and of a dark brown colour. Its taſte is bitter and aſtringent, and its virtues are the ſame as thoſe of the Jeſuit's bark. Infuſed in ſpirits or wine with a little orange-peel, it makes an excellent ſtomachic tincture.

PORT-LOUIS, is a ſtrong town of France, in Bretagne,

Port, Porto.

tagne, in the dioceſe of Vannes, with a citadel and a good harbour. It was fortified by Louis XIII. from whom it derived its name. It was a ſtation for part of the royal navy and the Eaſt India ſhips belonging to France. It is ſeated at the mouth of the river Blavet, 27 miles weſt of Vannes. W. Long. 3. 18. N. Lat. 47. 40.

Port-Mahon. See MINORCA.

PORTO. See OPORTO.

Porto-Bello, a town of North America, ſituated in N. Lat. 9. 3. W. Long. 79. 45. cloſe to the ſea, on the declivity of a mountain, which ſurrounds the whole harbour. This harbour is ſo large, deep, and ſafe, that Columbus, who firſt diſcovered it, gave it the name of *Porto-Bello*, or the "Fine Harbour," which is now commonly uſed to denote the town. The number of the houſes is about 130; moſt of them of wood, large and ſpacious, forming one long ſtreet along the ſtrand, with other ſmaller ones croſſing it. The governor of the town is always a gentleman of the army, ſubordinate to the preſident of Panama; but having under him the commandants of the forts that defend the harbour. At the eaſt end of the town, on the road to Panama, is a place called *Guinea*, where all the negroes of both ſexes, whether ſlaves or free, have their habitations. This place is very much crowded when the galleons are here, moſt of the inhabitants of the town quitting their houſes entirely for the ſake of letting them; while others content themſelves with a ſmall part, in order to make money of the reſt. The Mulattoes and other poor families alſo remove either to Guinea, or to cottages already erected near it, or built on the occaſion. Great numbers of artificers likewiſe who flock to Porto-Bello from Panama to work at their reſpective callings during the fair, lodge in Guinea for cheapneſs. Towards the ſea, in a large tract between the town and Gloria caſtle, barracks are erected, in moſt of which the ſhips crews keep ſtalls of ſweetmeats, and other kinds of eatables, brought from Spain; but at the concluſion of the fair, when the ſhips put to ſea, all theſe buildings are taken down, and the town returns to its former tranquillity and emptineſs. In 1739, the harbour was defended by a caſtle and two forts; which were all demoliſhed by admiral Vernon, who, with ſix ſhips only, made himſelf maſter of this port. The country about Porto-Bello is over-run with mountains and impenetrable foreſts, except a few valleys, in which are ſome ſcattered farms. Among the mountains that ſurround the harbour is one diſtinguiſhed by the name of *Capiro*, and by its ſuperior loftineſs is a ſort of barometer to the country, by foretelling every change of weather. Its top is always covered with clouds, of a denſity and darkneſs ſeldom ſeen in thoſe of the atmoſphere. When theſe clouds thicken, increaſe their blackneſs, and ſink below their uſual ſtation, it is a ſure ſign of a tempeſt; while, on the other hand, their clearneſs and aſcent as certainly indicate the approach of fair weather. Theſe changes are very ſudden and frequent here. The ſummit of the mountain is ſcarce ever clear from clouds; and when it happens, it is only, as it were, for an inſtant. Except in the time of the fair, all the inhabitants of Porto-Bello do not amount to 3000; half of whom are Indians, Mulattoes, or Negroes; the Spaniards of any ſubſtance not chooſing to reſide in a place ſo extremely unhealthy, and fatal even to the lives of the natives. Ulloa tells us, that the cattle brought hither from Panama or Carthagena, loſe their fleſh ſo faſt in the beſt paſtures, as to become ſcarce eatable: he aſſures us alſo, that neither horſes nor aſſes are bred here. The heat, indeed, is exceſſive; and the torrents of rain are ſo dreadful, ſudden, and impetuous, that one not accuſtomed to them would imagine a ſecond deluge was coming. Theſe torrents are alſo accompanied with frightful tempeſts of thunder and lightning, the awfulneſs of the ſcene being heightened by the repercuſſions from the mountains, and the ſhrieks and howlings of multitudes of monkeys of all kinds which inhabit the ſurrounding woods. Porto.

Freſh water pours down in ſtreams from the mountains, ſome running without the town, and others croſſing it. Theſe waters are very light and digeſtive; qualities which in other countries would be very valuable, but are here pernicious, producing dyſenteries, which the patient ſeldom ſurvives. However, theſe rivulets, formed into reſervoirs, ſerve the purpoſes of bathing, which is here found to be very conducive to health.

As the foreſts almoſt border on the houſes of the ſtreets, tygers often make incurſions into the ſtreets during the night, carrying off fowls, dogs, and other domeſtic animals, and ſometimes even children have fallen a prey to them. Beſides the ſnares uſually laid for them, the Negroes and Mulattoes, who fell wood in the foreſts of the mountains, are very dexterous in encountering them; and ſome, for a ſlender reward, even ſeek them in their retreats.

The town of Porto-Bello, which is thinly inhabited by reaſon of its noxious air, the ſcarcity of proviſions, and the barrenneſs of the ſoil, becomes, after the arrival of the galleons, one of the moſt populous towns in the world. He who had ſeen it quite empty, and every place wearing a melancholy aſpect, would be filled with aſtoniſhment to ſee the buſtling multitudes in the time of the fair, when every houſe is crowded, the ſquares and ſtreets encumbered with bales of merchandiſe and cheſts of gold and ſilver, the harbour full of ſhips and veſſels, ſome loaded with proviſions from Carthagena, and others with the goods of Peru, as cocoa, Jeſuit's bark, Vicuna wool, and bezoar ſtones; and this town, at all other times deteſted for its deleterious qualities, becomes the ſtaple of the riches of the Old and New World, and the ſcene of one of the moſt conſiderable branches of trade in the univerſe. Formerly the fair was limited to no particular time; but as a long ſtay in ſuch a ſickly place extremely affected the health of the traders, his Catholic majeſty tranſmitted an order that the fair ſhould not laſt above 40 days; and that, if in that time the merchants could not agree on their rates, thoſe of Spain ſhould be allowed to carry their goods up the country to Peru: and accordingly, the commodore of the galleons has orders to re-embark them, and return to Carthagena; but otherwiſe, by virtue of a compact between the merchants of both kingdoms, and ratified by the king, no Spaniſh trader is to ſend his goods, on his own account, beyond Porto-Bello. The Engliſh were formerly allowed to ſend a ſhip annually to this fair, which turned

Porto, Portrait.

ed to great account; and, whilſt the aſſiento contract ſubſiſted, either with the Engliſh or the French, one of their principal factories was at Porto-Bello.

Porto-Farina, a port about 12 miles from Cape Carthage, in the bay of Tunis, where formerly the large veſſels belonging to the bey were fitted out, and laid up on their return from a cruize. This harbour is ſafe from the weather, and opens into a large lake, formed by the Mejerdah, which runs through into the ſea.—The north-weſt wind, which blows right upon the ſhore, together with the ſoil brought down by the river, which has the ſame quality as the Nile of overflowing its banks, has formed a bar, ſo that only ſmall veſſels can now enter. It is ſtill the arſenal where the naval ſtores are kept. E. Long. 10. 16. N. Lat. 37. 12.

Porto-Farraio, a handſome town of Italy, in the iſle of Elba, with a good citadel. It is very ſtrong, and ſeated on a long, high, ſteep point of land, to the weſt of the bay of the ſame name, which has two forts. It belongs to the great duke of Tuſcany, who always keeps a good garriſon there. E. Long. 10. 37. N. Lat. 48. 55.

Porto-Longone, a ſmall but very ſtrong town of Italy, and in the iſle of Elba, with a good harbour, and a fortreſs upon a rock almoſt inacceſſible. The king of Naples has a right to put a garriſon therein, though the place belongs to the prince of Piombino. It is ſeated on the eaſt end of the iſland, eight miles ſouth-weſt of Piombino. E. Long. 10. 10. N. Lat. 42. 52.

Porto-Santo, an iſland of the Atlantic Ocean, on the coaſt of Africa, and the leaſt of thoſe called the *Madeiras*. It is about 15 miles in circumference, and produces but little corn; however, there are oxen and wild hogs, and a vaſt number of rabbits. There are trees which produce the gum or reſin called *dragon's blood*; and there is likewiſe a little honey and wax, which are extremely good. It has no harbour, but good mooring in the road. It belongs to the Portugueſe, and is 300 miles weſt of the coaſt of Africa. W. Long. 16. 20. N. Lat. 32. 58.

Porto-Seguro, a government of South America, on the eaſtern coaſt of Braſil; bounded on the north by the government of Rio-dos-Hilios, on the eaſt by the North Sea, on the ſouth by the government of Spiritu-Santo, and on the weſt by the Tupicks. It is a very fertile country, and the capital town is of the ſame name. It is built on the top of a rock, at the mouth of a river, on the coaſt of the North Sea, and is inhabited by Portugueſe. W. Long. 38. 50. S. Lat. 17. 0.

Porto-Vecchio, is a ſea-port town of Corſica, in the Mediterranean Sea, ſeated on a bay on the eaſtern coaſt of the iſland. It is 12 miles from Bonifacio, and 40 north of Sardinia. E. Long. 9. 20. N. Lat. 41. 42.

Porto-Venereo, is a town of Italy, on the coaſt of Genoa, at the entrance of the gulph of Spetia. It is ſeated on the ſide of a hill, at the top of which there is a fort. It has a very good harbour, and is 45 miles ſouth-eaſt of Genoa. E. Long. 9. 38. N. Lat. 44. 5.

PORTRAIT, or Portraiture, in painting, the repreſentation of a perſon, and eſpecially of a face, done from the life. In this ſenſe we uſe the term *portrait-painting*, in contradiſtinction to *hiſtory-painting*, where a reſemblance of perſons is uſually diſregarded. Portraits, when as large as the life, are uſually painted in oil-colours; ſometimes they are painted in miniature with water-colours, crayons, paſtils, &c. See Painting, p. 641.

Portree, Portſmouth.

PORTREE, is a ſmall village, containing a church and a very few houſes, with an excellent bay and a good harbour, in the Iſle of Sky. "The entrance of the bay (Mr Knox tells us) repreſents agreeable landſcapes on both ſides, with excellent paſture. *Knox's Tour.*

'The bay of Portree (ſays Mackenzie), off the houſes, is an exceeding good harbour for a few ſhips of any ſize; it is well ſheltered, the ground good, the depth from five to 14 fathoms, and nothing to fear coming in but a rock, about half a cable's length from Airderachig Point, on the ſtarboard as you enter the anchorage, part of which is always above water.' It is the only port or harbour to a very conſiderable diviſion of Sky, on the eaſt ſide. From this opening to the northern extremity, a courſe of 20 miles, the ſhore is one continued line of lofty rocks, where no ſhip can find refuge in the mildeſt weather, and where inevitable dangers await the mariners in rough weather.

"James V. of Scotland and ſeveral of his nobility landed here, when they made the tour of the Hebrides in 1535; from which circumſtance, this fine bay has got the honourable name of *Portree*."

Mr Knox tells us, "that the country round this village, though mountainous, is well inhabited; it raiſes much grain, and many cattle. Here the late Sir James Macdonald had marked out the lines of a town; and government, it is ſaid, promiſed to aſſiſt him in the work with 500 l.; but the death of that gentleman put an end to theſe promiſing appearances, and matters remain in *ſtatu quo*."

PORTSMOUTH, a ſea-port town in Hampſhire, with one of the moſt ſecure and capacious harbours in England, being defended by a numerous artillery, both on the ſea and land-ſide, and very good fortifications. A great part of the royal navy is built here; and here are ſome of the fineſt docks, yards, and magazines of naval ſtores, in Europe. It is ſeated in the iſle of Portſey, being ſurrounded by the ſea except on the north ſide, where there is a river which runs from one arm of it to the other. It is much reſorted to on account of the royal navy, whoſe uſual rendezvous is at Spithead, which is at the eaſt end of the iſle of Wight, and oppoſite to Portſmouth. There is a draw-bridge over the river, and it has always a good garriſon. It is governed by a mayor, 12 aldermen, and burgeſſes, and ſends two members to parliament. It has one church, and two chapels, one in the garriſon, and one in the Common, for the uſe of the dock, and others, beſides ſeveral meeting-houſes of the diſſenters. The houſes of Portſmouth amount to about 2000, and the inhabitants to about 12,000. W. Long. 1. 1. N. Lat. 50. 47.

The town is ſuppoſed to receive its name from Port, a famous Saxon chieftain, who, A. D. 501. landed here with his two ſons. It made a conſiderable figure in the time of the Saxons; and from the utility of its ſituation, was highly favoured by all our monarchs of the Norman line. It was incorporated, and became alſo a parliamentary borough. In the reign of Edward III. it was in a very flouriſhing ſtate; but, A. D. 1338, in the very ſame reign, was burned by the French, when

Portſmouth || Portugal.

when that monarch, which was afterwards ratified by king Richard II. forgave the inhabitants a debt, and remitted their fee-farm for 10 years; within which ſpace they ſo recovered themſelves, as to equip a ſquadron, which ſailed into the mouth of the Seine, ſunk two ſhips, and brought away a great booty. The ſingular excellence of its port, and the convenience of fitting out fleets from thence in the time of a French war, induced Edward IV. to think of fortifying it, as he actually, in ſome meaſure, did; which fortifications were farther carried on by Richard III. But king Henry VII. was the firſt who ſettled a garriſon therein; which was increaſed, and the place made ſtill ſtronger, in the reign of Henry VIII. who had a great dock there, wherein was built the Henry Grace de Dieu, which was the largeſt ſhip in the navy of his time. The ſame monarch, remarkably attentive to the ſecurity of all maritime places, built what is now called *South-Sea Caſtle*, for the protection of this.—The improvements made here in the reign of Q. Elizabeth were much ſuperior to all theſe. King Charles II. after his reſtoration, directed great alterations, eſtabliſhed new docks and yards, raiſed ſeveral forts, and fortified them after the modern manner; which works were augmented under his brother's reign. Notwithſtanding this, king William directed likewiſe freſh alterations and additions; and ſucceeding princes, following his example, have, at a large expence, extended theſe fortifications, and taken in a vaſt deal of ground: ſo that it is at preſent, as the importance of the place deſerves, the moſt regular fortreſs in Britain; and, as it cannot be effectually attacked by ſea, may be juſtly eſteemed impregnable.

Campbell's Political Survey.

PORTSMOUTH, the largeſt town in the ſtate of New Hampſhire in North America. It ſtands on the ſouth-eaſt ſide of Piſcataqua river, about two miles from the ſea, and contains about 600 houſes, and 4400 inhabitants. The town is handſomely built, and pleaſantly ſituated. Its public buildings are, a court-houſe, two churches for Congregationaliſts, one for Epiſcopalians, and one other houſe for public worſhip. Its harbour is one of the fineſt on the continent, having a ſufficient depth of water for veſſels of any burthen. It is defended againſt ſtorms by the adjacent land, in ſuch a manner, as that ſhips may ſecurely ride there in any ſeaſon of the year. Beſides, the harbour is ſo well fortified by nature, that very little art will be neceſſary to render it impregnable. Its vicinity to the ſea renders it very convenient for naval trade. A light-houſe, with a ſingle light, ſtands at the entrance of the harbour.

PORTSOY, is a handſome ſea-port town, ſituated on a ſmall promontory running into the ſea, on the ſouth ſide of the Murray Frith, in Scotland, about ſix miles from Cullen, and ſeven weſt from Banff. It ſends out ſeveral fiſhing veſſels, particularly for the Hebride white fiſhery, and exports a conſiderable quantity of grain. A manufacture of ſtocking and ſewing thread is alſo carried on to a conſiderable amount for the London and Nottingham markets. In the neighbourhood is a ſtratum of marble, of a dark greeniſh colour, in which, it is ſaid, the curious ſubſtance called ASBESTOS, or earth-flax, has been found. From the aſbeſtos a ſort of incombuſtible cloth is made, which is purified by throwing it into the fire. W. Long. 2. 5. N. Lat. 57. 50.

PORTUGAL, the moſt weſterly kingdom of Europe, bounded on the weſt and ſouth by the Atlantic Ocean, and on the eaſt and north by Spain; extending about 310 miles in length, and 150 in breadth.

Portugal.

See *Map* of Spain and Portugal.

1 Boundaries.

By modern writers, we find this country conſtantly ſtyled in Latin *Luſitania*; and it is certain, that anciently a country of Spain went by that name; but it does not by any means appear that the country called by the ancients *Luſitania* had the ſame boundaries with the modern kingdom of Portugal. Before Auguſtus Cæſar, Luſitania ſeems to have been bounded on the north by the ocean, and on the ſouth by the river Tagus; by which means it comprehended all Galicia, and excluded two of the ſix provinces of Portugal. But in the more ſtrict and reſtrained ſenſe of the word, it was bounded on the north by the Durius, now the Douro, and on the ſouth by the river Anas, now the Guadiana; in which ſenſe it was not quite ſo long as modern Portugal, but conſiderably broader.

2 Etymology of the name.

The commonly received opinion with regard to the etymology of the word *Portugal*, is, that a great number of Gauls landed at Porto, or Oporto, whence it received the name of *Portus Gallorum*, or *the Port of the Gauls*; and in proceſs of time that name gradually extended over the whole country, being ſoftened, or rather ſhortened, into *Portugal*. But the time when this event happened, the reaſon why theſe Gauls came thither, and what became of them afterwards, are all particulars which lie buried in oblivion. It is alleged, however, that, upon an eminence which overlooks the mouth of the river Douro, there ſtood an ancient town called *Cale*, ſtrong and well peopled, but ill ſeated for trade; and this occaſioned the conſtruction of a lower town or hamlet, which was called *Portus Cale*, that is, *the haven of Cale*; and, in proceſs of time, *Portucalia*. At length, becoming ſo conſiderable as to merit an epiſcopal chair, the biſhops ſubſcribed themſelves, as the records of ancient councils teſtify, *Portucalenſes*, and the name of the city was transferred to the dioceſe. It is true, that theſe biſhops afterwards changed their title, and ſubſcribed themſelves *Portuenſes*, that is, *biſhops of Porto*. But the facts juſt mentioned are actually recorded in authentic hiſtories; and as the dioceſe of Portucalia contained in a great meaſure that little country in which the ſovereignty originally began, the name extended itſelf, together with the acquiſitions of the ſovereigns, and has remained to the kingdom, though the dioceſe itſelf has changed its name, and poſſibly on that very account.

3 Originally only a ſmall kingdom.

Portugal, though even yet but a ſmall kingdom, was originally much ſmaller. The Spaniſh and Portugueſe hiſtorians agree, that Don Alonſo, king of Leon and Caſtile, and ſon to Don Ferdinand the Great, beſtowed his daughter Donna Thereſa in marriage upon an illuſtrious ſtranger, Don Henry, and gave him with her the frontier province which he had conquered from the Moors, ſmall indeed in extent, but excellently ſituated, and ſo pleaſant and fertile, that it has ſometimes been ſtyled *Medulla Hiſpanica*, or *the marrow of Spain*. To this territory was added the title of *Count*; but authors are much divided about the time that this ſtranger came into Spain, and who he was. However, the authors of the Univerſal Hiſtory make it pretty evident, that he was a grandſon of Robert the firſt duke of Burgundy. The manner in which

Portugal.

which he obtained the principality above-mentioned is related as follows:

The king, Don Alonſo, apprehenſive that his ſucceſs in taking the city of Toledo would bring upon him the whole force of the Moors, ſent to demand aſſiſtance from Philip I. of France, and the duke of Burgundy, whoſe daughter he had married. His requeſt was granted by both princes; and a numerous body of troops was ſpeedily collected for his ſervice, at whoſe head went Raymond count of Burgundy, Henry younger brother of Hugh duke of Burgundy, Raymond count of Tholouſe, and many others. They arrived at the court of Don Alonſo in the year 1087, where they were received and treated with all poſſible marks of eſteem; and having in the courſe of two or three years given great proofs of their courage and conduct, the king reſolved to beſtow his only daughter named *Urraca*, then a mere child, being at moſt in her ninth year, upon Raymond count of Burgundy, and aſſigned them the province of Galicia for the ſupport of their dignity. About four years after, Don Alonſo being very deſirous to expreſs his gratitude to Henry of Burgundy, gave him in marriage a natural daughter of his, born while he remained in exile at Toledo, whoſe name was *Donna Thereſa;* and upon this marriage, he gave up in full property the country which has been already mentioned.

4 Henry of Burgundy the firſt count of Portugal.

The new ſovereign, with his conſort, fixed their reſidence in the town of Guimaraez, pleaſantly ſituated on the banks of the river Ave. The remains of an ancient palace belonging to their ſucceſſors are ſtill to be ſeen; and on account of its having been anciently the capital, the king, Don Denis, granted the inhabitants an immunity from taxes, which they ſtill enjoy.

The Portugueſe, now finding themſelves independent, immediately began, like other nations, to attempt the ſubjection of their neighbours. Henry is ſaid to have performed great exploits againſt the Moors; but the accounts of them are ſo indiſtinct, that they cannot be taken notice of here. He died in 1112; and was ſucceeded by his ſon Don Alonſo, then an infant in the third year of his age. In his minority, the kingdom was governed by his mother Donna Thereſa, aſſiſted by two able miniſters. During the firſt nine years of their adminiſtration, nothing remarkable happened; but after that period, ſome differences took place between the queen regent (for ſhe had aſſumed the title of queen after her father's death) and Urraca queen of Caſtile. Thereſa inſiſted, that ſome part of Galicia belonged to her in virtue of her father's will; and therefore ſeized on Tuy, an epiſcopal town, and a place of ſome conſequence. Urraca, having aſſembled a numerous army, went in perſon into Galicia; upon which Thereſa was obliged to abandon Tuy, and take ſhelter in one of her own fortreſſes. The conſequences, in all probability, would have been fatal to the new kingdom, had not the archbiſhop of Compoſtella, without whoſe aſſiſtance Urraca could do nothing, demanded leave to retire with his vaſſals. This offended the queen to ſuch a degree, that ſhe threw him into priſon; which act of violence excited ſuch a commotion among her own ſubjects, that the Portugueſe were ſoon delivered from their apprehenſions. Queen Thereſa fell immediately after into a ſimilar error, by throwing into priſon the archbiſhop of Braga, who had not eſpouſed her cauſe ſo warmly as ſhe had expected. The biſhop, however, was quickly delivered by a bull from the pope, who alſo threatened the kingdom with an interdict; and this was the firſt remarkable offence which Thereſa gave her ſubjects.

5 Differences with Caſtile.

Soon after this, Queen Urraca died, and all differences were amicably ſettled at an interview between Thereſa and Don Alonſo Raymond, who ſucceeded to the kingdom of Caſtile. But, in 1126, the king of Caſtile being obliged to march with the whole ſtrength of his dominions againſt his father-in-law the king of Navarre and Arragon, Thereſa took the opportunity of again ſeizing upon Tuy; but the king ſoon returning with a ſuperior army, ſhe was again obliged to abandon her conqueſt. But the greateſt misfortune which befel this princeſs, was a quarrel with her own ſon Don Alonſo Enriquez. It does not appear indeed that Thereſa had given him any juſt cauſe of offence; but it is certain that a civil war enſued, in which the queen's forces were totally defeated, and ſhe herſelf made priſoner, in which ſituation ſhe continued during the remainder of her life.

6 Don Alonſo's wars with the Moors and king of Caſtile.

Enriquez having thus attained to the free and full poſſeſſion of his dominions, made ſeveral attempts upon ſome places in Galicia, but without ſucceſs; ſo that he was at laſt conſtrained to make peace with Alonſo king of Caſtile and Leon, who had aſſumed the title of *Emperor of the Spains;* the more eſpecially as his dominions happened to be at that time invaded by the Moors.—The number of infidels was ſo great, that the count of Portugal had little hopes of ſubduing them; but a plague breaking out in the Mooriſh army, they were obliged to retreat; after which he reduced ſeveral places belonging to that nation. But, in the mean time, the emperor Don Alonſo, breaking into the Portugueſe territories, deſtroyed every thing with fire and ſword. The king of Portugal ſurpriſed and cut off a conſiderable part of his army; which, however, did not hinder the emperor from marching directly towards him.—But, at the interceſſion of the pope's legate, all differences were accommodated, and a peace concluded; all places and priſoners taken on both ſides being delivered up.

In the mean time, the progreſs of the Chriſtian arms in Spain being reported to Abu-Ali Texefien, the miramamolin or chief monarch of the Moors in Barbary, he directed Iſmar, or Iſhmael, his lieutenant in Spain, to aſſemble all the forces in the ſouthern provinces, and drive the Chriſtians beyond the Douro. Iſhmael immediately began to prepare for putting theſe orders in execution; and having added a conſiderable body of troops brought from Barbary to thoſe whom he had raiſed in Spain, the whole army was very numerous. He was met by Don Alonſo of Portugal, in the plains of Ourique, on the banks of the river Tayo; and Iſhmael took all poſſible means to prevent the Chriſtians from paſſing that river, becauſe his own cavalry, in which the ſtrength of his army chiefly conſiſted, had thus more room to act. The Portugueſe forces were very inconſiderable in number in compariſon of the Moors; but Iſhmael, being too confident of victory, divided his army into 12 bodies, and diſpoſed them in ſuch a manner as might beſt prevent the flight, not ſuſtain the attack, of the Chriſtians. The conſequence was,

7 Victory of Ourique.

that

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that his army was overthrown with incredible ſlaughter, and a vaſt number of priſoners taken, among whom were 1000 Chriſtians, of the ſect ſtyled *Mozarabians*, whom, at the requeſt of Theotonus, prior of the Holy Croſs, Don Alonſo ſet at liberty with their wives and children, and procured them ſettlements in his own dominions.

8 Don Alonſo aſſumes the title of king.

After this ſignal victory, gained in the year 1139, Don Alonſo was proclaimed king by his ſoldiers, and ever after retained that title, renouncing all kind of ſubjection to the crown of Spain. Being very deſirous, however, of bringing down the power of the emperor, he entered into a league with Raymond count of Barcelona and regent of the kingdom of Arragon againſt that prince. In conſequence of this treaty, he entered Galicia with a conſiderable force on one ſide, while Don Raymond did the ſame on the other. Neither of theſe enterpriſes, however, ſucceeded. The Portugueſe monarch met with a ſevere check in his expedition into Galicia, where he received a dangerous wound, and had ſome of the nobility who attended him taken priſoners. At the ſame time he received intelligence that the Moors had invaded his dominions, ſo that he was obliged to retire; which, however, was not done in ſufficient time to prevent the ſtrong fortreſs of Leyria from falling into their hands. This fortreſs they demoliſhed, and put all the garriſon to the ſword; but the king cauſed it to be rebuilt ſtronger than before, and put a more numerous garriſon into it; however, he undertook nothing farther this campaign. The war continued with various ſucceſs till the year 1145, when the king projected an enterpriſe againſt Santaren, a ſtrong city about 12 miles from Liſbon. In this he luckily ſucceeded: and by that means gained a conſiderable track of country, and a ſtrong barrier to his dominions.

After this ſucceſs Don Alonſo cauſed himſelf with much ceremony to be choſen and crowned king of Portugal before an aſſembly of the ſtates, where he alſo ſolemnly renounced all dependence on the crown of Spain, declaring, that if any of his ſucceſſors ſhould condeſcend to pay tribute or to do homage to that crown, he was unworthy of enjoying the kingdom of Portugal. The next year the king undertook the recovery of Liſbon out of the hands of the Moors; and concerning this expedition there are ſuch numbers of fables, that it is almoſt impoſſible to come at the truth. What can be gathered from theſe accounts is, that he undertook the ſiege with a ſmall army, and was able to make but little progreſs in it, partly from the ſtrength of the place, and partly from the numerous garriſon by which it was defended. At length, fortunately for Don Alonſo, a fleet of adventurers, French, Engliſh, Germans, and Flemings, that were going to the Holy Land, anchored at the mouth of the river Tagus, whoſe aſſiſtance he demanded, as not altogether foreign to their deſign of making war on the infidels. His requeſt was readily granted; and, with their aſſiſtance, Liſbon was ſpeedily reduced; which conqueſt ſo much raiſed the reputation of this monarch, and brought ſuch numbers to recruit his army, that before the end of the year 1147 he had reduced 12 other conſiderable cities.

9 Reduces Liſbon and 12 other cities.

10 Has his regal dignity confirmed by the pope.

For many years after this, Don Alonſo was ſucceſsful in all his undertakings. He ſettled the internal government of his kingdom, procured a bull from pope Alexander III. confirming his regal dignity, undertook many ſucceſsful expeditions againſt the Moors, and became maſter of four of the ſix provinces which compoſe the preſent kingdom of Portugal. In all his undertakings he was aſſiſted by the counſels of his Queen Matilda, who was a woman of great capacity, and ſufficient for the government of the kingdom in her huſband's abſence. By her he had a numerous offspring, particularly three daughters; the eldeſt of whom, Donna Mafalda or Mathilda, was married to the king of Arragon; the ſecond, Urraca, to Don Ferdinand king of Leon; and the third, Thereſa, to Philip earl of Flanders. In 1166, however, the king thought proper, from what provocation we know not, to invade the dominions of his ſon-in-law Don Ferdinand; and poſſeſſed himſelf of Limmia and Turon, two cities of Galicia, in which he put ſtrong garriſons. The next year, elated with his ſucceſs, he marched with a numerous army towards Badajos, which he inveſted; on the news of which, Don Ferdinand, who had aſſembled a large army at Ciudad Rodrigo, marched to its relief. Yet before he could come within ſight of it, it had ſurrendered to the king of Portugal; upon which Don Ferdinand came to a reſolution of beſieging his antagoniſt in his newly conquered city; which Don Alonſo perceiving, endeavoured to draw out his forces into the field. Though he was at that time upwards of 70 years of age, he was himſelf on horſeback, and puſhing forwards at the head of his horſe to get out at the gate, he ſtruck his leg againſt one of the bolts with ſuch violence that the bone was ſhattered to pieces. This accident occaſioned ſuch confuſion, that the Portugueſe troops were eaſily beaten, and Don Alonſo was taken priſoner. He was exceedingly mortified by this diſgrace, eſpecially as he had no great reaſon to expect very kind treatment from his ſon-in-law. However, the king of Leon behaved towards him with the greateſt reſpect and affection. He deſired him to lay aſide all thoughts of buſineſs, and attend to his cure; but finding him reſtleſs and impatient, he aſſured him that he expected nothing more than to have things put into the ſame condition as before the war, and that they might live in peace and friendſhip for the future: to which the king of Portugal moſt readily aſſented; but returned to his dominions before his cure was perfected, which was the cauſe of his being lame all the reſt of his life. However, this did not abate his military ardour; for, notwithſtanding this inconvenience, his courage tranſported him into the field whenever he was called by the intereſt of his ſubjects. Towards the end of his reign, an opportunity ſeemed to preſent itſelf of obtaining once for all an entire releaſe from the diſagreeable pretenſions of the king of Leon, who, it ſeems, had inſiſted on the king of Portugal's doing homage for his kingdom. The opportunity which now preſented itſelf was a quarrel between the king of Leon and his nephew Don Alonſo king of Caſtile. The latter aſked aſſiſtance from the king of Portugal, which was readily granted. But Don Ferdinand, having received intelligence that the infant Don Sancho (the king's eldeſt ſon) was advancing towards Ciudad Rodrigo, aſſembled his troops on that frontier with ſuch diligence, that he was enabled to attack him unexpectedly, and entirely defeated him. Underſtanding, however, that Don Sancho was recruiting his forces with great diligence, he

11 His unſucceſsful war with Don Ferdinand of Spain.

12 Don Sancho's ſucceſs againſt the Moors.

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he let him know that they might be much better employed againſt the infidels, who remained careleſs and unprepared, expecting the iſſue of the war. Don Sancho made a proper uſe of this advice; and, after making ſome motions to amuſe the enemy, made a ſudden irruption into Andaluſia, penetrating as far as Triana, one of the ſuburbs of Seville. The Moors aſſembled their forces in order to attack him on his retreat; but Don Sancho having firſt fatigued them by the celerity of his march, at length choſe a ſtrong camp, and, having given his troops time to repoſe, drew them out and offered the enemy battle. The Moors accepted the challenge, but were entirely defeated; and Don Sancho returned into Portugal with ſpoils to an immenſe amount. For ſome years after the war was continued without any remarkable event; but, in 1184, Joſeph king of Morocco, having already tranſported multitudes of men from Barbary, at length followed in perſon with a prodigious army, and carried all before him as far as the Tayo. He appeared before the city of Santaren; but having wearied and reduced his army by unſucceſsful aſſaults on that place, he was attacked by the Portugueſe forces aſſiſted by Ferdinand of Leon, entirely defeated, and himſelf killed. By this victory, the Portugueſe were left at liberty to improve the interior part of their country, and fortify their frontiers; and during this interval, the king died in the 76th year of his age, in the year 1185.

13 His wiſe adminiſtration when king.

Don Alonſo was ſucceeded by his ſon Don Sancho I. Of this prince it is remarkable, that, before he aſcended the throne, he was of a reſtleſs and warlike diſpoſition; but no ſooner did he come to the poſſeſſion of the kingdom, than he became a lover of peace, and began with great aſſiduity to repair the cities that had ſuffered moſt by the war, and to repeople the country around them. By his ſteady attention to this, he in a very ſhort time quite altered the appearance of his territories, and procured to himſelf the glorious title of *The reſtorer of cities, and father of his country*. In the year 1189, a fleet, compoſed for the moſt part of Engliſh veſſels, but having on board a great number of adventurers of other nations bound to the Holy Land, entered the river of Liſbon. They were very kindly received, and ſupplied with all kinds of refreſhments by Don Sancho, who took this opportunity of ſoliciting them to aſſiſt him in a deſign he had formed of attacking the city of Silves in Algarve; to which they readily yielded. Having joined a ſquadron of his own galleys, and marched a body of troops by land, the place was reduced, and the Engliſh, according to agreement, rewarded with the plunder. But, in a ſhort time, the Moors from Africa having again invaded Portugal, the town was ſeveral times taken and retaken, till at laſt Don Sancho, being ſenſible of the difficulties that would attend the keeping of it, cauſed it to be demoliſhed. His laſt enterpriſe was the reduction of Elvas; ſoon after which he died with the reputation of the beſt economiſt that ever ſat on the throne of Portugal. With the character of being rather liberal than avaricious, he had amaſſed a treaſure of more than 700,000 crowns in ready money, beſides 1400 merks of ſilver and 100 of gold plate, which he diſpoſed of ſome time before his death. He was interred by his own command with much leſs pomp than his father, in the cathedral of Coimbra; and when his body was taken up 400 years after by order of the king Don Emanuel that it might be laid in a new tomb, it was found uncorrupted.

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14 Differences with Caſtile.

The hiſtory of Portugal affords ſcarce any event of importance till the year 1289; when, in the reign of Don Denis, a difference commenced with Caſtile, which ſubſiſted for a long time. Frequent reconciliation took place; but theſe were either of very ſhort duration, or never ſincere. An length, in the reign of John I. Don Juan of Caſtile, who had alſo pretenſions to the crown of Portugal, invaded that kingdom at the head of the whole force of his dominions, and with the flower of the Caſtilian nobility entered the province of Alentego. According to the Portugueſe hiſtorians, he beſieged the city of Elvas without effect; which diſappointment enraged him to ſuch a degree, that he determined next year to invade Portugal a ſecond time, and ruin all the country before him. Accordingly, having collected an army of 30,000 men, he invaded Portugal, took and ruined ſeveral places, while King John lay inactive, with a ſmall army, waiting for ſome Engliſh ſuccours which he expected. At laſt he ventured an engagement with the forces which he had; and, notwithſtanding the great ſuperiority of the enemy, obtained a complete victory; after which he made an irruption into Caſtile, and had the good fortune to gain another battle, which fixed him firmly on the throne of Portugal. The Caſtilians were obliged to conſent to a truce of three years, which was ſoon after improved into a laſting peace.

15 The Caſtilians entirely defeated.

16 The city of Ceuta taken from the Moors.

In 1414, King John undertook an expedition againſt the Moors in Barbary, where he commanded in perſon; but before he ſet out, his queen (Philippa the daughter of John duke of Lancaſter) died of grief at the thoughts of his abſence. The expedition, however, proved ſucceſsful, and the city of Ceuta was taken from the Moors almoſt at the firſt aſſault: but ſcarce had the king left that country, when the princes of Barbary formed a league for the recovery of it; and though they were defeated by the young princes of Portugal, whom John again ſent into Barbary, yet the trouble of keeping it was ſo great, that ſome of the king's council were of opinion that the town ſhould be demoliſhed. But John, having conſidered the arguments on both ſides, determined to keep the city; and therefore enlarged and ſtrengthened the fortifications, augmenting his forces there to 6000 foot and 2500 horſe, which he hoped would be ſufficient for keeping off the attacks of the Moors.

King John died in 1428, and was ſucceeded by his eldeſt ſon Edward. He undertook an expedition againſt Tangier in Barbary: but the event proved very unfortunate; the Portugueſe being ſo ſhut up by the Moors, that they were obliged to offer Ceuta back again, in order to obtain leave to return to Portugal. The king's ſon, Don Ferdinand, was left as a hoſtage for the delivery of Ceuta; but was, with the utmoſt cruelty and injuſtice, left in the hands of the infidels, by the king and council of Portugal, who conſtantly refuſed to deliver up the place. Many preparations indeed were made for recovering the prince by force; but before any thing could be accompliſhed the king died in 1430, which put an end to all theſe deſigns. See PEDRO (Don).

17 Paſſage to the Eaſt Indies diſcovered.

The war with Barbary continued at intervals, but with little ſucceſs on the part of the Portugueſe; and till

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till the year 1497, there is no event of any conſequence recorded in the hiſtory of Portugal. This year was remarkable for the diſcovery of the paſſage to the Eaſt Indies by the Cape of Good Hope. The enterpriſing ſpirit of the Portugueſe had prompted them to undertake voyages along the coaſt of Africa for a conſiderable time before; but when they undertook their firſt voyage of diſcovery, it is probable that they had nothing farther in view than to explore thoſe parts of the coaſt of Africa which lay neareſt to their own country. But a ſpirit of enterpriſe, when rouſed and put in motion, is always progreſſive; and that of the Portugueſe, though ſlow and timid in its firſt operations, gradually acquired vigour, and prompted them to advance along the weſtern ſhore of the African continent, far beyond the utmoſt boundary of ancient navigation in that direction. Encouraged by ſucceſs, it became more adventurous, deſpiſed dangers which formerly appalled it, and ſurmounted difficulties which it once deemed inſuperable. When the Portugueſe found in the torrid zone, which the ancients had pronounced to be uninhabitable, fertile countries, occupied by numerous nations; and perceived that the continent of Africa, inſtead of extending in breadth towards the weſt, according to the opinion of Ptolemy, appeared to contract itſelf, and to bend eaſtwards, more extenſive proſpects opened to their view, and inſpired them with hopes of reaching India, by continuing to hold the ſame courſe which they had ſo long purſued.

Robertſon's India.

After ſeveral unſucceſsful attempts to accompliſh what they had in view, a ſmall ſquadron ſailed from the Tagus, under the command of Vaſco de Gama, an officer of rank, whoſe abilities and courage fitted him to conduct the moſt difficult and arduous enterpriſes. From unacquaintance, however, with the proper ſeaſon and route of navigation in that vaſt ocean through which he had to ſteer his courſe, his voyage was long and dangerous. At length he doubled that promontory, which, for ſeveral years, had been the object of terror and of hope to his countrymen. From that, after a proſperous navigation along the ſouth-eaſt of Africa, he arrived at the city of Melinda, and had the ſatisfaction of diſcovering there, as well as at other places where he touched, people of a race very different from the rude inhabitants of the weſtern ſhore of that continent, which alone the Portugueſe had hitherto viſited. Theſe he found to be ſo far advanced in civilization and acquaintance with the various arts of life, that they carried on an active commerce, not only with the nations on their own coaſt, but with remote countries of Aſia. Conducted by their pilots, who held a courſe with which experience had rendered them well acquainted, he ſailed acroſs the Indian ocean, and landed at Calecut, on the coaſt of Malabar, on the 22d of May 1498, ten months and two days after his departure from the port of Liſbon.

18 Circumſtances which facilitated the diſcovery.

19 The king of the country jealous of his new viſitors.

The ſamorin, or monarch of the country, aſtoniſhed at this unexpected viſit of an unknown people, whoſe aſpect, and arms, and manners, bore no reſemblance to any of the nations accuſtomed to frequent his harbours, and who arrived in his dominions by a route hitherto deemed impracticable, received them at firſt with that fond admiration which is often excited by novelty; but in a ſhort time, from whatever motives, he formed various ſchemes to cut off Gama and his followers. The Portugueſe admiral, however, was not to be over-reached by ſuch politics as his. From every danger to which he was expoſed, either by the open attacks or ſecret machinations of the Indians, he extricated himſelf with ſingular prudence and dexterity, and at laſt ſailed from Calecut with his ſhips, loaded not only with the commodities peculiar to that coaſt, but with many rich productions of the eaſtern parts of India. He returned to Portugal in two years after his ſailing from the Tagus, but with a great loſs of men; for out of 148 perſons whom he took out with him, only 55 returned. The king received him with all poſſible teſtimonies of reſpect and kindneſs; created him count of Videgueira; and not only declared him admiral of the Indies, but made that office hereditary in his family. Portugal.

20 The Venetians dread the ruin of their commerce.

On the firſt intelligence of Gama's ſucceſsful voyage, the Venetians, with the quick-ſighted diſcernment of merchants, foreſaw the immediate conſequence of it to be the ruin of that lucrative branch of commerce which had contributed ſo greatly to enrich and aggrandize their country; and they obſerved this with more poignant concern, as they were apprehenſive that they did not poſſeſs any effectual means of preventing, or even retarding, its operation.

21 Account of the ſettlement of the Portugueſe in India.

The hopes and fears of both were well-founded. The Portugueſe entered upon the new career opened to them with activity and ardour, and made exertions, both commercial and military, far beyond what could have been expected from a kingdom of ſuch inconſiderable extent. All theſe were directed by an intelligent monarch, capable of forming plans of the greateſt magnitude with calm ſyſtematic wiſdom, and of proſecuting them with unremitting perſeverance. The prudence and vigour of his meaſures, however, would have availed little without proper inſtruments to carry them into execution. Happily for Portugal, the diſcerning eye of Emanuel ſelected a ſucceſſion of officers to take the ſupreme command in India, who, by their enterpriſing valour, military ſkill, and political ſagacity, accompanied with diſintereſted integrity, public ſpirit, and love of their country, have a title to be ranked with the perſons moſt eminent for virtue and abilities in any age or nation. Greater things perhaps were atchieved by them than were ever accompliſhed in ſo ſhort a time. Within 24 years only after the voyage of Gama, the Portugueſe had rendered themſelves maſters of the city of Malacca, in which the great ſtaple of trade carried on among the inhabitants of all thoſe regions in Aſia, which Europeans have diſtinguiſhed by the general name of the *Eaſt Indies*, was then eſtabliſhed. This conqueſt ſecured to them great influence over the interior commerce of India, while, at the ſame time, by their ſettlements at Goa and Diu, they were enabled to engroſs the trade of the Malabar coaſt, and to obſtruct greatly the long eſtabliſhed intercourſe of Egypt with India by the Red Sea. In every part of the eaſt they were received with reſpect; in many they had acquired the abſolute command. They carried on trade there without rival or controul; they preſcribed to the natives the terms of their mutual intercourſe; they often ſet what price they pleaſed on the goods which they purchaſed; and were thus enabled to import from Indoſtan and the regions beyond it, whatever is uſeful, rare, or agreeable, in greater abundance, and of more various kinds, than had been known formerly in Europe.

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Not ſatisfied with this aſcendant which they had acquired in India, the Portugueſe early formed a ſcheme no leſs bold than intereſted, of excluding all other nations from participating of the advantages of commerce with the eaſt; and they accompliſhed one half of what their ambition had planned.

22 Oppoſition made by the Venetians.

In conſequence of this, the Venetians ſoon began to feel that decreaſe of their own Indian trade which they had foreſeen and dreaded. In order to prevent the farther progreſs of this evil, they incited the Soldan of the Mameluks to fit out a fleet in the Red Sea, and to attack thoſe unexpected invaders of a gainful monopoly, of which he and his predeceſſors had long enjoyed undiſturbed poſſeſſion. The Portugueſe, however, encountered his formidable ſquadron with undaunted courage, entirely defeated it, and remained maſters of the Indian ocean. They continued their progreſs in the eaſt almoſt without obſtruction, until they eſtabliſhed there a commercial empire; to which, whether we conſider its extent, its opulence, the ſlender power by which it was formed, or the ſplendor with which the government of it was conducted, there had hitherto been nothing comparable in the hiſtory of nations. Emanuel, who laid the foundation of this ſtupendous fabric, had the ſatisfaction to ſee it almoſt completed. Every part of Europe was ſupplied by the Portugueſe with the productions of the eaſt; and if we except ſome inconſiderable quantity of them, which the Venetians ſtill continued to receive by the ancient channels of conveyance, our quarter of the globe had no longer any commercial intercourſe with India, and the regions of Aſia beyond it, but by the Cape of Good Hope.

In September 1522, King Emanuel died of an epidemical fever, and was ſucceeded by his ſon John III.

23 Inquiſition introduced into Portugal.

The moſt remarkable tranſaction of this prince's reign was the introduction of the inquiſition into his dominions. This happened in the year 1525, or, as ſome ſay, in 1535. A famine happening to ceaſe in a ſhort time after it was introduced, the prieſts perſuaded the ignorant multitude that it was a bleſſing from heaven on account of the erecting ſuch an holy tribunal. However, it was not long before the bulk of the nation perceived what kind of a bleſſing the inquiſition was: but their diſcernment came too late; for by that time the inquiſitors had acquired ſuch power, that it became equally dangerous and ineffectual to attempt diſcloſing any of their myſteries.

In the mean time Solyman the Magnificent, the moſt enlightened monarch of the Ottoman race, obſerving the power and the opulence of the Portugueſe riſing, and attributing it to its proper cauſe, and eager to ſupplant them, ſent orders to the baſhaw of Egypt to employ his whole ſtrength againſt the Chriſtians in the Eaſt Indies. The baſhaw, in obedience to theſe orders, ſailed out from the Red Sea with a greater naval force than ever the Mohammedans had employed before; having 4000 Janizaries, and 16,000 other land troops on board. Yet, by the courage and conduct of the Portugueſe officers and ſoldiers, all this mighty armament was defeated, and their Eaſt India poſſeſſions ſaved from the danger which threatened them. In Africa likewiſe the king of Fez was baffled before the town of Safi, and freſh quarrels breaking out among the princes gave great relief to the Chriſtians, who had long been obliged to carry on a defenſive war, and had more than once been on the very brink of ruin. For a long time indeed their ſafety had been derived only from the quarrels of the Moors among themſelves; for ſuch was the envy and jealouſy which reigned among the Portugueſe, that they could never unite heartily in oppoſing the common enemy; and therefore, had their enemies united againſt them, they muſt certainly have been cut off. But whenever the cheriffs quarrelled with each other, one party was ſure to have recourſe to the Portugueſe; who, by ſending them a ſmall ſupply, ſecured quiet to themſelves, and had the pleaſure of ſeeing their enemies deſtroy one another. Yet in the end even this had bad conſequences; for, on one hand, it kept up a martial ſpirit among the Moors, and on the other it made them acquainted with the Portugueſe diſcipline; ſo that after every ſhort interval of repoſe they not only found them as much enemies as before, but much more formidable than ever. The conſequence of all this was, that King John began to apprehend that the conqueſt of Barbary was impoſſible, and therefore to limit his deſires to the keeping of thoſe few fortreſſes which he had already; which, though a neceſſary and prudent meaſure, diſpleaſed the generality of his ſubjects.

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24 Bad ſtate of affairs in Barbary.

King John exerted himſelf much in the ſettlement of Brazil in South America, which he brought into a very good ſtate, cauſed ſeveral ſtrong towns to be erected there, and took all poſſible methods to encourage the converſion of the natives to Chriſtianity. He alſo made many regulations for the welfare and happineſs of his ſubjects. The diſputes of the nobility about precedency were frequently attended with very diſagreeable conſequences, which made the king reſolve once for all to ſettle them by eſtabliſhed rules; and the rules eſtabliſhed by him on this occaſion have ſubſiſted ever ſince, and in a great meaſure prevent theſe altercations. He had other great deſigns in his mind, particularly with regard to the reformation, which he had puſhed very far with reſpect to religious perſons of both ſexes; but, on a cloſe examination of his affairs, he found his ſubjects in general to have been ſo much injured by his leaving their concerns to the inſpection of his council, that he was thrown by the grief of it into a kind of apoplexy, from which he never recovered. His death happened in June 1557; and he was ſucceeded by his ſon Don Sebaſtian III. an infant of three years of age.

After the death of King John, the adminiſtration remained in the hands of the queen, grandmother to Sebaſtian, who behaved with great prudence and circumſpection. The Moors, however, ſuppoſing that under a minority they might be able to diſpoſſeſs the Chriſtians of ſuch places as they held in Barbary, laid cloſe ſiege to Maſagnan. But the queen-regent ſent ſuch ſpeedy ſuccours, and promiſed ſuch rewards to thoſe who diſtinguiſhed themſelves, that the Moors, though they brought 80,000 men into the field, were obliged to abandon the enterpriſe. This was at firſt magnified as a high inſtance of the queen's capacity and wiſdom; but in a ſhort time the natural averſion which the Portugueſe had to the government of women, together with the prejudice they had againſt her country, as being a Caſtilian, appeared ſo plainly, and gave her ſo much uneaſineſs, that of her own accord ſhe reſigned her authority into the hands of cardinal Don Henry

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the king's brother. By him Don Alexius de Meneſes was appointed the king's governor, and Gonſales de Gomera with two other prieſts his preceptors. By means of thoſe inſtructors the king's education was totally marred. His governor aſſiduouſly inculcated upon him that the chief virtue of a king was courage; that danger was never to be avoided, but always ſurmounted, let the occaſion be what it would. His other tutors, inſtead of inſtructing him in the true religion, only inſpired him with an abhorrence of profeſſed infidels: the conſequence of all which was, that he became raſh, inconſiderate, and obſtinate; all which qualities conſpired to draw upon him the cataſtrophe which ruined both him and the kingdom.

25 Preposterous education of the young king Sebaſtian.

After the king was grown up to man's eſtate, his deſire was to diſtinguiſh himſelf againſt the infidels. He himſelf choſe an expedition to the Eaſt Indies; but the prime miniſter Alcoçova, who did not chooſe to attend his monarch to ſuch a diſtance, ſubſtituted Africa in its ſtead. This expedition the king entered into in the moſt inconſiderate and abſurd manner. He firſt ſent over Don Antonio prior of Crato, with ſome hundreds of ſoldiers; carried his principal courtiers over with him from a hunting match, and without equipages; he then ſent for the duke of Aveyro, with ſuch troops as he could collect on the ſhort warning he had got; and when all theſe were aſſembled, the king ſpent his time in hunting, and ſlight excurſions againſt the enemy, without doing any thing of conſequence, except expoſing his perſon upon all occaſions. At length he returned to Portugal in ſuch tempeſtuous weather, that his ſubjects had given him up for loſt; when they were agreeably ſurpriſed by his unexpected arrival in the river of Liſbon, which they celebrated with the greateſt rejoicings.

26 He undertakes an expedition againſt Africa.

The little ſucceſs which attended the king in this expedition ſerved only to inflame him more with deſire for another; ſo that from the time he returned, he ſeemed to think on nothing elſe. He was highly delighted alſo with an accident which at this time furniſhed him with a pretence for war, though of that he ſtood in no great need. Muley Hamet, king of Fez and Morocco, had been diſpoſſeſſed of his dominions by his uncle Muley Moloch. At the beginning of this war Don Sebaſtian had offered him his troops in Africa, which offer was rejected with contempt: but now being a fugitive, and having in vain applied for aſſiſtance to Philip of Spain, Muley Hamet applied to the king of Portugal; and, that he might the more eaſily ſucceed, cauſed the fortreſs of Arzila, which his father had recovered, to be reſtored to the Portugueſe. The king was in rapture at this event, and fancied that his glory would exceed that of all his predeceſſors. He was adviſed againſt this expedition, however, by all his friends. King Philip of Spain having done every thing to diſſuade him from it in a perſonal conference, ſent Franciſco Aldana, an old and experienced officer, to Morocco; and at his return ordered him to attend Don Sebaſtian, in order to give him an account of the ſtate of affairs in that country. This he performed with the greateſt fidelity, but without any effect. The queen dowager and cardinal united in their endeavours to divert him from this unfortunate enterpriſe; but he treated them both with ſo little reſpect, that his grandmother broke her heart; and the cardinal, to ſhow his diſtaſte to the meaſure, retired to Evora without coming either to court or council; which example was followed by many of the nobles. Many of theſe, however, ſent very free remonſtrances to the king on the impropriety of his conduct; and King Philip ſent to him the duke de Medina Celi, once more to lay before him the reaſons why he thought his ſcheme impracticable, and to put him in mind that he had no hand in puſhing him upon his deſtruction, or of concealing from him the dangers into which he ſeemed determined to plunge himſelf and his ſubjects. Laſtly, he received a letter on the ſubject from Muley Moloch himſelf, wherein that prince explained to him his own right to the crown of Fez, and ſhowed that he had only diſpoſſeſſed a tyrant and a murderer, who had therefore no right to his friendſhip or aſſiſtance. He next aſſured him that he had no reaſon to fear either the power or neighbourhood of the Portugueſe; as a proof of which, and as a mark of his eſteem, he was content to make him a preſent of ten miles of arable ground round each of the fortreſſes he poſſeſſed in Africa, and which indeed were no more than four, viz. Tangier, Ceuta, Maſagan, and Arzila. At the ſame time he addreſſed himſelf to King Philip of Spain, with whom he was on good terms, deſiring him to interpoſe with his nephew Sebaſtian, that things might be yet adjuſted without the effuſion of human blood. But the king of Portugal was deaf to all ſalutary advice; and therefore paid no regard to this letter, nor to the remonſtrances of his uncle. On the 24th of June 1577, therefore, he ſet ſail from the bar of Liſbon with a fleet of 50 ſhips and five galleys, twelve pieces of cannon, and tranſports and tenders, making up near 1000 ſail. His troops conſiſted of 9000 Portugueſe foot; 3000 Germans; 700 Italians commanded by Sir Thomas Stukeley, an Engliſh exile, but remarkably brave; 2000 Caſtilians and 300 volunteers, commanded by Don Chriſtopher de Tuvara maſter of the horſe, a man of courage, but without either conduct or experience. He touched firſt at Lagos bay in the kingdom of Algarve, where he remained for four days: thence he proceeded to Cadiz; where he was magnificently feaſted for a week by the duke de Medina Sidonia, who took the opportunity once more, by order of Philip, of diſſuading him from proceeding further in perſon. But this exhortation proved as fruitleſs as the reſt; and the king having ſailed with a ſtrong detachment for Tangier, ordered Don Diego de Souza, his commander in chief, to follow with the remaining part of the army.

27 Account of his forces.

The troops landed on the coaſt of Africa without any bad accident, and joined at Arzila. Here the king was met by the cheriff Muley Hamet, on whoſe account he had undertaken the war, who delivered him his ſon Muley, a boy of 12 years of age, as a hoſtage, and brought a reinforcement of 300 Moors. The boy was ſent to Maſagan under a ſtrong guard; but the father remained in the Portugueſe camp. Here it was reſolved in a council of war to reduce the town of Larache, but it was diſputed whether the troops ſhould proceed thither by land or ſea. Don Sebaſtian, who eſpouſed the former opinion, finding himſelf oppoſed by Muley Hamet, gave him ſuch a rude anſwer, that he left his preſence in diſcontent; after which the king's opinion prevailed, and the army began its march on the 29th of July. As they proceeded, the king received a

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letter from the duke of Alba, requeſting him to attempt nothing beyond the taking of the town of Larache. Along with the letter was ſent an helmet which had been worn by Charles V.

28 Movements and diſpoſition of the armies.

On the other hand Muley Moloch, having intelligence of this formidable invaſion, took the field, though at that time ſo ill of a fever that he could not ſit on horſeback, with 40,000 foot and 60,000 horſe. He conducted every thing, notwithſtanding his diſtreſſed ſituation, with the greateſt prudence. Finding ſome reaſon to ſuſpect that part of his army were deſirous of going over to his rival, he proclaimed that ſuch as inclined to join their old maſter were at liberty to do it. This at once put a ſtop to the defection, and only a very few made uſe of the liberty which was granted them. Standing in doubt likewiſe of the fidelity of a body of 3000 horſe, he ſent them to reconnoitre the enemy, by which act of confidence he ſecured them. Still, however, he feared that his officers might be corrupted by the Portugueſe gold; for which reaſon he changed the diſpoſition of his army entirely, ſo that none of his officers commanded the corps to which they had been accuſtomed; and therefore, having new men to deal with, had none whom they could truſt.

Having taken theſe precautions, he advanced againſt the Portugueſe army with ſuch celerity, that he came in ſight of them on the 3d of Auguſt. On this Don Sebaſtian called a council of war; in which many who out of complaiſance had given their opinions for this march, were now for returning. They were ſeparated from the enemy by a river, and the Moors were maſters of the ford, ſo that it was impoſſible to force them immediately in their poſts; neither was it practicable for them to wait for a more favourable opportunity, becauſe they had no proviſions. The foreign officers, on the contrary, were of opinion that fighting was now become neceſſary, and a retreat dangerous. This, however, was violently oppoſed by the cheriff, who ſaw plainly that they ran a great riſk of being defeated and of loſing all, while at the ſame time they were not certain of gaining any thing of conſequence though they ſhould be victorious: whereas, if they drew down towards the ſea, they might entrench themſelves till they were relieved by their fleet; during which interval if Muley Moloch ſhould die, he looked upon it as certain that a great part of the army would deſert to him, which would render him maſter not only of the kingdom, but of the fate of the Chriſtians alſo. When he found that the king was bent on fighting, he only requeſted that the engagement might be delayed till 4 o'clock in the afternoon, that, in caſe of a defeat, they might have ſome chance of eſcaping: but even in this he could not prevail; for the king having diſpoſed of every thing for a battle the next day, was impatient to begin the onſet as ſoon as it was light.

In the mean time Muley Moloch was ſo ſenſible of the advantages of his ſituation, that he was inclined to take the whole Portugueſe army priſoners; but finding his diſeaſe increaſe, ſo that he had no hopes of recovery, he came to the reſolution to fight, that his antagoniſt might not avail himſelf of his death. The diſpoſition of the Chriſtian army was very regular and correct, through the care of ſome old officers in Don Sebaſtian's ſervice: the infantry were diſpoſed in three lines; the battalion of volunteers made the vanguard; the Germans commanded by colonel Amberg, and the Italians by Sir Thomas Stuckeley, were on the right; the Caſtilian battalions on the left; the Portugueſe in the centre and rear; the cavalry, conſiſting of about 1500 men, partly on the right under the command of the duke d'Avegro, to whom the cheriff joined himſelf with his horſe: on the left was the royal ſtandard, with the reſt of the cavalry, under the command of the duke of Barcelos eldeſt ſon to the duke of Braganza, Don Antonio prior of Crato, and ſeveral other perſons of great rank. The king took poſt at firſt with the volunteers. Muley Moloch diſpoſed alſo his troops in three lines: the firſt conſiſted of the Andaluſian Moors, commanded by three officers who had diſtinguiſhed themſelves in the wars of Granada; the ſecond of renegadoes; and the third of the natives of Africa. They moved in a half moon, with 10,000 horſe on each wing, and the reſt in the rear, with orders to extend themſelves in ſuch a manner as to encompaſs the Chriſtian army. Muley Moloch, though extremely weak, was taken out of his litter, and ſet on horſeback, that he might ſee how his commands had been obeyed; and being perfectly ſatisfied with the ſituation of his troops, he directed the ſignal of battle to be given. The Chriſtians advanced with the greateſt reſolution; broke the firſt line of the Mooriſh infantry, and diſordered the ſecond. On this Muley Moloch drew his ſword, and would have advanced to encourage his troops, but that his guards prevented him; on which his emotion of mind was ſo great, that he fell from his horſe. One of his guards caught him in his arms, and conveyed him to his litter; where he immediately expired, having only time to lay his finger on his lips by way of enjoining them to conceal his death. But by this time the Mooriſh cavalry had wheeled quite round, and attacked the Chriſtian army in the rear: upon which the cavalry in the left wing made ſuch a vigorous effort that they broke the Portugueſe on the right; and at this time the cheriff, in paſſing a rivulet, was drowned. In this emergency, the Germans, Italians, and Caſtilians, did wonders; but the Portugueſe, according to their own hiſtorians, behaved indifferently. Attacked on all ſides, however, they were unable to reſiſt; and the whole army, except about 50 men, were killed or taken priſoners. The fate of the king is variouſly related. According to ſome, he had two horſes killed under him, and then mounted a third. His braveſt officers were killed in his defence; after which the Moors ſurrounding him, ſeized his perſon, ſtripped him of his ſword and arms, and ſecured him. They immediately began to quarrel about whoſe priſoner he was; upon which one of the generals rode in among them, crying, "What, you dogs, when God has given you ſo glorious a victory, would you cut one anothers throats about a priſoner?" at the ſame time diſcharging a blow at Sebaſtian, he brought him to the ground, when the reſt of the Moors ſoon diſpatched him. Others affirm, that one Lewis de Brito meeting the king with his ſtandard wrapped round him, Sebaſtian cried out, "Hold it faſt, let us die upon it!" upon which charging the Moors, he was ſeized, reſcued by Brito, who was himſelf taken with the ſtandard, and carried to Fez. He affirmed, that after he was taken, he ſaw the king at a diſtance, and unpurſued. Don Lewis de Lima met him afterwards

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29 The Portugueſe army entirely defeated.

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Muley Hamet, the brother of Muley Moloch, was proclaimed king by the Moors immediately after the battle. Next day, having ordered all the priſoners to be brought before him, the new ſovereign gave orders to ſearch for the body of Don Sebaſtian. The king's valet-de-chambre brought back a body, which he ſaid was that of his maſter, but ſo disfigured with wounds, that it could not well be known; ſo that notwithſtanding the moſt diligent ſearch, this monarch's death could never be properly authenticated. This body, however, was preſerved by Muley Hamet, who delivered it up as the body of Don Sebaſtian to King Philip of Spain. By him it was ſent to Ceuta, from whence it was tranſported to Portugal, and buried among his anceſtors in the monaſtery at Belem, with all poſſible ſolemnity.

By this terrible diſaſter, the kingdom of Portugal, from being the moſt eminent, ſunk at once into the loweſt rank of the European ſtates. All the young nobility were cut off, or carried into ſlavery: the kingdom was exhauſted of men, money, and reputation; ſo that Don Henry, who aſſumed the government after the death of his brother Don Sebaſtian, found himſelf in a very diſagreeable ſituation. The tranſactions of his reign were quite trifling and unimportant; but after his death a great revolution took place. The crown of Portugal was claimed by three different competitors; viz. the prince of Parma, the dutcheſs of Braganza, and Philip of Spain. Whatever might have been the merits of their reſpective claims, the power of Philip quickly decided the conteſt in his favour. He found his ſchemes facilitated by the treachery of the regents, who took the moſt ſcandalous methods of putting the kingdom into his hands. Under pretence of inſpecting the magazines, they took out ſome of the powder, and mixed the reſt with ſand; they appointed an agent to go to France for ſuccours, from whence they knew that they could not arrive in time; they diſſolved the ſtates as ſoon as they diſcovered that they were bent on maintaining the freedom of the nation; and, under a ſhow of confidenee, ſent off to diſtant places ſuch of the nobility as they ſuſpected.

30 Portugal conquered by Philip of Spain.

King Philip, finding every thing in his favour, commanded the duke of Alva to invade Portugal, at the head of 20,000 men. The people, perceiving that they were betrayed, exclaimed againſt the governors, and placed on the throne Don Antonio prior of Crato. But his forces being inexperienced, and he himſelf behaving in a very improper manner, he was quickly defeated by the duke of Alva, and forced to fly out of the kingdom, which he effected with great difficulty. On his flight the whole kingdom ſubmitted, together with the garriſons in Barbary, the ſettlements on the weſtern coaſt of Africa, of Brazil, and in the Eaſt Indies. All the Madeiras, however, except the iſle of St Michael, held out for Don Antonio until they were reduced, and the French navy, who came to their aſſiſtance, entirely defeated and deſtroyed.

31 Terms granted by him to his new ſubjects.

Philip made his entry into Liſbon as ſoon as the kingdom was totally reduced, and endeavoured to conciliate the affections of the people by confirming the terms which he had before offered to the ſtates. Theſe terms were, that he would take a ſolemn oath to maintain the privileges and liberties of the people: that the ſtates ſhould be aſſembled within the realm, and nothing propoſed in any other ſtates that related to Portugal: that the viceroy or chief governor ſhould be a native, unleſs the king ſhould give that charge to one of the royal family: that the houſehold ſhould be kept on the ſame footing: that the poſt of firſt preſident, and of all offices, civil, military, and judicial, ſhould be filled with Portugueſe; all dignities in the church and in the orders of knighthood confined to the ſame; the commerce of Ethiopia, Africa, and the Indies, reſerved alſo to them, and to be carried on only by their merchants and veſſels: that he would remit all impoſts on eccleſiaſtical revenues: that he would make no grant of any city, town, or juriſdiction royal, to any but Portugueſe: that eſtates reſulting from forfeitures ſhould not be united to the domain, but go to the relations of the laſt poſſeſſor, or be given to other Portugueſe for recompenſe of ſervices: that when the king came to Portugal, where he ſhould reſide as much as poſſible, he ſhould not take the houſes of private perſons for his officers lodging, but keep to the euſtom of Portugal: that wherever his majeſty reſided, he ſhould have an eccleſiaſtic, a treaſurer, a chancellor, two maſters of requeſts, with under officers, all of them Portugueſe, who ſhould diſpatch every thing relating to the kingdom: that Portugal ſhould ever continue a diſtinct kingdom, and its revenue be conſumed within itſelf: that all matters of juſtice ſhould be decided within the realm: that the Portugueſe ſhould be admitted to charges in the houſeholds of the king and queen of Spain: that all duties on the frontiers ſhould be taken away: and, laſtly, that Philip ſhould give 300,000 ducats to redeem priſoners, repair cities, and relieve the miſeries which the plague and other calamities had brought upon the people. All theſe conditions, formerly offered and rejected by the Portugueſe, the king now confirmed: but whereas the duke of Oſſuna, by way of ſecurity for theſe conditions, had promiſed them a law, that if the king did not adhere to them, the ſtates ſhould be freed from their obedience, and might defend their right by the ſword, without incurring the reproach of perjury, or the guilt of treaſon; this he abſolutely refuſed to ratify.

32 Cannot conciliate their affections.

All theſe conceſſions, however, did not anſwer the purpoſe; nay, though Philip was to the laſt degree laviſh of honours and employments, the Portugueſe were ſtill diſſatisfied. This had alſo an effect which was not foreſeen: it weakened the power, and abſorbed the revenues, of the crown; and, by putting it out of the power of any of his ſucceſſors to be liberal in the ſame proportion, it raiſed only a ſhort-lived gratitude in a few, and left a number of malecontents, to which time was continually adding.

33 Is diſturbed by Don Antonio.

Thus Philip, with all his policy, and endeavours to pleaſe, found his new ſubjects ſtill more and more diſguſted with his government, eſpecially when they found their king treating with the utmoſt ſeverity all thoſe who had ſupported Don Antonio. The exiled prince, however, ſtill ſtyled himſelf *king of Portugal*. At firſt he retired to France, and there demanded ſuccours for the recovery of his dominions. Here he found ſo much countenance, that with a fleet of near 60 ſail, and a good body of troops on board, he made an attempt upon the Terceras, where his fleet was beat by the Spaniards; and a great number of priſoners being taken,

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ken, all the officers and gentlemen were beheaded, and a great number of meaner people hanged. Don Antonio, notwithſtanding, kept poſſeſſion of ſome places, coined money, and performed many other acts of regal power; but was at length conſtrained to retire, and it was with ſome difficulty that he did ſo, and returned into France. He paſſed from thence into England, where he was well received; and many fitted out privateers to cruiſe againſt the Spaniards under his commiſſion. But after king Philip had ruined the naval power of Portugal as well as Spain, by equipping the armada, Queen Eliſabeth made no difficulty of owning and aſſiſting Don Antonio, and even of ſending Sir John Norris and Sir Francis Drake with a ſtrong fleet and a great army to reſtore him. Upon this occaſion Don Antonio ſent his ſon Don Chriſtopher a hoſtage to Muley Hamet king of Fez and Morocco, who was to lend him 200,000 ducats. But king Philip prevented this by ſurrendering Arzila: and this diſappointment, the unſeaſonable enterpriſe upon Corunna, and the diſputes that aroſe between Norris and Drake, rendered that expedition abortive; ſo that, except carrying the plague into England, it was attended with no conſequences worthy of notice. He remained ſome time after in England: but finding himſelf little regarded, he withdrew once more into France, where he fell into great poverty and diſtreſs; and at length dying in the 64th year of his age, his body was buried in the church of the nuns of Ave Maria, with an inſcription on his tomb, in which he is ſtyled *king*. He left ſeveral children behind him, who, on account of his being a knight of Malta, and having made a vow of virginity at his entrance into the order, were looked upon as illegitimate. He preſerved, even to the day of his death, a great intereſt in Portugal; and had drawn from thence, in the courſe of his life, immenſe ſums of money; which had been ſquandered in many fruitleſs negociations and attempts to diſturb the poſſeſſions of king Philip in almoſt all parts of his dominions, and particularly in the Indies, where the Portugueſe were rather more averſe to the Caſtilian yoke, or at leaſt teſtified their averſion more openly, than in Europe.

34 Impoſtors pretending to be Don Sebaſtian.

But Don Antonio was not the only pretender to the crown of Portugal: for the people, partly through the love of their prince, and partly from their hatred to the Caſtilians, were continually feeding themſelves with the hopes that Don Sebaſtian would appear and deliver them; and in this reſpect ſuch a ſpirit of credulity reigned, that it was ſaid proverbially, they would have taken a negro for Don Sebaſtian. This humour put the ſon of a tiler at Alcobaza, who had led a profligate life, and at length turned hermit, to give himſelf out for that prince; and having with him two companions, one of them ſtyled himſelf *Don Chriſtopher de Tavora*, and the other the *biſhop of Guarda*, they began to collect money, and were in a fair way of creating much diſturbance, if the cardinal arch-duke had not cauſed him to be apprehended; and after leading him ignominiouſly through the ſtreets of Liſbon, he who took the name of *Sebaſtian* was ſent to the galleys for life, and the pretended biſhop was hanged. Not long after, Gonſalo Alvarez, the ſon of a maſon, gave himſelf out for the ſame king; and having promiſed marriage to the daughter of Pedro Alonſo, a rich yeoman, who m he created earl of Torres Novas, he aſſembled a body of about 800 men, and ſome blood was ſpilt before he was apprehended: at length, being clearly proved to be an impoſtor, himſelf and his intended father-in-law were publicly hanged and quartered at Liſbon; which, inſtead of extinguiſhing this humour, farther increaſed it.

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35 Account of a remarkable one.

There was, however, a perſon who appeared, about 20 years after the fatal defeat of Sebaſtian, at Venice, who created much more trouble. He aſſumed the name of *Don Sebaſtian*, and gave a very diſtinct account of the manner in which he had paſſed his time from that defeat. He affirmed, that he had preſerved his life and liberty by hiding himſelf amongſt the ſlain: that, after wandering in diſguiſe for ſome time in Africa, he returned with two of his friends into the kingdom of Algarve: that he gave notice of this to the king Don Henry: that finding his life ſought, and being unwilling to diſturb the peace of the kingdom, he returned again among the Moors, and paſſed freely from one place to another in Barbary, in the habit of a penitent: that after this he became a hermit in Sicily; but at length reſolved to go to Rome, and diſcover himſelf to the pope. On the road he was robbed by his domeſtics, and came almoſt naked to Venice, where he was known, and acknowledged by ſome Portugueſe. Complaint being made to the ſenate, he was obliged to retire to Padua. But the governor of that city ordering him alſo to depart, he, not knowing what to do, returned again to Venice; where, at the requeſt of the Spaniſh ambaſſador, who charged him not only with being an impoſtor, but alſo with many black and atrocious crimes, he was ſeized, and thrown into priſon. He underwent 28 examinations before a committee of noble and impartial perſons; in which he not only acquitted himſelf clearly of all the crimes that had been laid to his charge, but entered alſo into ſo minute a detail of the tranſactions that had paſſed between himſelf and the republic, that the commiſſioners were perfectly aſtoniſhed, and ſhowed no diſpoſition to declare him an impoſtor; moved more eſpecially by the firmneſs of his behaviour, his ſingular modeſty, the ſobriety of his life, his exemplary piety, and his admirable patience under his afflictions. The noiſe of this was diffuſed throughout Europe, and the enemies of Spain endeavoured everywhere to give it credit.

The ſtate, however, refuſed to diſcuſs the great point, whether he was or was not an impoſtor, unleſs they were requeſted ſo to do by ſome prince or ſtate in alliance with them. Upon this the prince of Orange ſent Don Chriſtopher, the ſon of the late Don Antonio, to make that demand; and at his requeſt an examination was made with great ſolemnity: but no deciſion followed; only the ſenate ſet him at liberty, and ordered him to depart their dominions in three days. He went therefore, by the advice of his friends, to Padua, but in the diſguiſe of a monk, and from thence to Florence; where he was arreſted by the command of the grand duke, who delivered him to the viceroy of Naples. The count de Lemos, then in poſſeſſion of that dignity, died ſoon after, before whom he was firſt brought; this man aſſerted, he muſt know him to be Don Sebaſtian, ſince he had been twice ſent to him from the king of Spain. He remained priſoner ſeveral years in the caſtle Del Ovo, where he endured incredible hardſhips. At length he was brought out, led with infamy through the ſtreets

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of the city, and declared to be an impoſtor, who aſſumed the name of *Sebaſtian*: at which words, when proclaimed before him, he ſaid gravely, *And ſo I am*. In the ſame proclamation it was affirmed, that he was in truth a Calabrian; which as ſoon as he heard, he ſaid, *It is falſe*. He was next ſhipped on board a galley as a ſlave; then carried to St Lucar, where he was ſome time confined; from thence he was transferred to a caſtle in the heart of Caſtile, and never heard of more. Some perſons were executed at Liſbon for their endeavours to raiſe an inſurrection on his behalf: but it was thought ſtrange policy, or rather a ſtrange want of policy, in the Spaniards, to make this affair ſo public without proofs; and the attempt to ſilence this objection, by affirming him to be a magician, was juſtly looked upon as ridiculous.

36 Bad conſequences of the Spaniſh adminiſtration.

The adminiſtration of affairs in Portugal, during the reign of Philip, was certainly detrimental to the nation; and yet it does not appear that this flowed ſo much from any ill intention in that monarch, as from errors in judgment. His prodigious preparations for the invaſion of England impoveriſhed all his European dominions; but it abſolutely exhauſted Portugal. The pretenſions of Don Antonio, and the hopes of deſpoiling their Indian fleets, expoſed the Portugueſe to the reſentment of the Engliſh; from which the king having granted away all his domains, wanted power to defend them. Their clamours were not at all the leſs loud for their being in ſome meaſure without cauſe. The king, to pacify them, borrowed money from the nobility upon the cuſtoms, which were the only ſure remedy he had ſtill left; and this was attended with fatal conſequences. The branches, thus mortgaged, became, and continue to this hour, fixed and hereditary; ſo that the merchant was oppreſſed, and the king received nothing. This expedient failing, a tax of three *per cent.* was impoſed, in the nature of ſhip-money, for the defence of the coaſts and the commerce, which for ſome years was properly applied; but it then became a part of the ordinary revenue, and went into the king's exchequer without account. This made way for diverting other appropriated branches; as for inſtance, that for the repair of fortifications, the money being ſtrictly levied, and the works ſuffered to decay and tumble down; and for the maintenance of the conqueſts in Africa, by which the garriſons mouldered away, and the places were loſt. Upon the whole, in the ſpace of 18 years, the nation was viſibly impoveriſhed: and yet the government of Philip was incomparably better than that of his ſucceſſors; ſo that his death was juſtly regretted; and the Portugueſe were taught by experience to confeſs, that of bad maſters he was the beſt.

His ſon Philip, the ſecond of Portugal and the third of Spain, ſat 20 years upon the throne before he made a viſit to Portugal, where the people put themſelves to a moſt enormous expence to receive him; for which they received little more than the compliment, that before his entry into Liſbon, he knew not how great a king he was. He held an aſſembly of the ſtates, in which his ſon was ſworn ſucceſſor. Having done all that he wanted for himſelf, he acquired a falſe idea of the riches of the nation from an immoderate and fooliſh diſplay of them during his ſhort ſtay at Liſbon; and having ſhown himſelf little, and done leſs, he returned into Spain; where he acted the part of a good king upon his death-bed, in deploring bitterly that he never thought of acting it before. The reign of Philip III. and IV. was a ſeries of worſe meaſures, and worſe fortune: all his dominions ſuffered greatly; Portugal moſt of all. The loſs of Ormus in the Eaſt, of Brazil in the Weſt Indies, together with the ſhipwreck of a fleet ſent to eſcort that from Goa, brought the nation incredibly low, and encouraged the conde duke to hope they might be entirely cruſhed. Theſe are the heads only of the tranſactions for 40 years: to enter in any degree into the particulars, is, in other words, to point out the breaches made by the Spaniſh miniſters on the conditions granted by king Philip; which, with reſpect to them, was the original contract, and unalterable conſtitution of Portugal while ſubject to the monarchs of Caſtile; and which, notwithſtanding, they ſo often and ſo flagrantly violated, that one would have imagined they had ſtudied to provoke the wrath of heaven, and inſult the patience of men, inſtead of availing themſelves, as they might have done, of the riches, power, and martial ſpirit of the Portugueſe people.

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37 Great loſſes in Aſia and America.

38 The Portugueſe oppreſſed by the Spaniards.

It was the very baſis and foundation of their privileges, that the kingdom ſhould remain ſeparate and independent, and conſequently that Liſbon ſhould continue as much its capital as ever, the ſeveral ſupreme councils and courts reſiding; ſo that the natives of this realm might not be obliged to travel in ſearch of juſtice. So little, or at leaſt ſo ſhort a time, was this obſerved, that neither promotion nor juſtice was to be obtained without journeys, and Madrid was not more the capital of Caſtile than of Portugal. The general aſſembly of eſtates was to be held frequently, and they were held thrice in the ſpace of 60 years; and of theſe twice within the firſt three. The king was to reſide in this realm, as often and as long as poſſible; in compliance with which, Philip I. was there but once, Philip II. but four months, and Philip III. was never there at all. The houſehold eſtabliſhment was ſuppreſſed through all their reigns. The viceroy was to be a native of Portugal, or a prince or princeſs of the blood; yet when any of the royal family bore the title, the power was in reality in the hands of a Spaniard. Thus, when the princeſs of Mantua was vice-queen, the marquis de la Puebla was to aſſiſt in council, and in all diſpatches; and ſhe was to do nothing without his advice. The council of Portugal, which was to be compoſed entirely of natives, was filled with Caſtilians, as the garriſons alſo were, though the contrary had been promiſed. The preſidents of provinces, or corregidors, were to be natives; but by keeping thoſe offices in his own hands, the king eluded this article. No city, town, or diſtrict, were to be given but to Portugueſe; yet the duke of Lerma had Beja, Serpa, and other parts of the demeſnes of the crown, which were formerly appendages of the princes of the blood. None but natives were capable of offices of juſtice, in the revenue, in the fleet, or of any poſt civil or military; yet theſe were given promiſcuouſly to foreigners, or ſold to the higheſt bidder; not excepting the governments of caſtles, cities, and provinces. The natives were ſo far from having an equal chance in ſuch caſes, that no poſts in the preſidials were ever given to them, and ſcarce any in garriſons; and whenever it happened, in the caſe of a perſon of extraordinary merit, whoſe pretenſions could not be rejected, he was either removed, or not allowed to exerciſe his charge;

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as fell out to the marquis of Marialva and others. The forms of proceeding, the juriſdiction, the miniſters, the ſecretaries, were all changed, in the council of Portugal; being reduced from five to three, then two, and at laſt to a ſingle perſon.

39 A revolution in favour of the duke of Braganza.

By reaſon of theſe and many other grievances too tedious to be mentioned here, the deteſtation of the Spaniſh government became univerſal; and in 1640 a revolution took place, in which John duke of Braganza was declared king, by the title of John IV. This revolution, as being determined by the almoſt unanimous voice of the nation, was attended with very little effuſion of blood; neither were all the efforts of the king of Spain able to regain his authority. Several attempts indeed were made for this purpoſe. The firſt battle was fought in the year 1644, between a Portugueſe army of 6000 foot and 1100 horſe, and a Spaniſh army of nearly the ſame number. The latter were entirely defeated; which contributed greatly to eſtabliſh the affairs of Portugal on a firm baſis. The king carried on a defenſive war during the remainder of his life; but after his death, which happened in 1655, the war was renewed with great vigour.

40 Perilous ſtate of Portugal on his death.

This was what the Spaniards did not expect; for they expreſſed a very indecent kind of joy at his death, hoping that it would be followed by a diſſolution of the government. It is not indeed eaſy to conceive a kingdom left in more perilous circumſtances than Portugal was at this time:—The king Don Alonzo Enriquez, a child not more than 13 years of age, reputed of no very ſound conſtitution either in body or mind; the regency in a woman, and that woman a Caſtilian; the nation involved in a war, and this reſpecting the title to the crown; the nobility, ſome of them ſecretly diſaffected to the reigning family, and almoſt all of them embarked in feuds and contentions with each other; ſo that the queen ſcarce knew who to truſt or how ſhe ſhould be obeyed. She acted, however, with great vigour and prudence. By marrying her only daughter the princeſs Catharine to Charles II. King of Great Britain, ſhe procured to Portugal the protection of the Engliſh fleets, with reinforcements of ſome thouſands of horſe and foot; and at laſt, in 1665, terminated the war by the glorious victory of Monteſclaros. This deciſive action broke the power of the Spaniards, and fixed the fate of the kingdom, though not of the king, of Portugal. Alonzo was a prince whoſe education had been neglected in his youth, who was devoted to vulgar amuſements and mean company, and whom the queen for theſe reaſons wiſhed to deprive of the crown, that ſhe might place it on the head of his younger brother Don Pedro. To accompliſh this purpoſe, ſhe attempted every method of ſtern authority and ſecret artifice; but ſhe attempted them all in vain. The Portugueſe would not conſent to ſet aſide the rights of primogeniture, and involve the kingdom in all the miſeries attending a diſputed ſucceſſion. After the death, however, of the queen-mother, the infant entered into cabals againſt the king of a much more dangerous nature than any that ſhe had carried on. Alonzo had married the princeſs of Nemours; but being, as was ſaid, impotent, and likewiſe leſs handſome than his brother, that lady transferred her affection to Don Pedro, to whom ſhe lent her aſſiſtance to hurl the king from the throne. Alonzo was compelled to ſign a reſignation of the kingdom; and his brother, after governing a few months without any legal authority, was in a meeting of the ſtates unanimouſly proclaimed regent, and veſted with all the powers of royalty. Soon after this revolution, for ſuch it may be called, the marriage of the king and queen was declared null by the chapter of Liſbon; and the regent, by a papal diſpenſation, and with the conſent of the ſtates, immediately eſpouſed the lady who had been wife to his brother. He governed, under the appellation of *regent*, 15 years, when, upon the death of the king, he mounted the throne by the title of Don Pedro II. and after a long reign, during which he conducted the affairs of the kingdom with great prudence and vigour, he died on the 9th of December 1706.

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41 Don Alonzo obliged to reſign the throne.

42 Don John V. a wiſe and reſolute prince.

Don John V. ſucceeded his father; and though he was then little more than 17 years of age, he acted with ſuch wiſdom and reſolution, adhered ſo ſteadily to the grand alliance formed againſt France and Spain, and ſhowed ſuch reſources in his own mind, that though he ſuffered great loſſes during the war, he obtained ſuch terms of peace at Utrecht, that Portugal was in all reſpects a gainer by the treaty. The two crowns of Spain and Portugal were not, however, reconciled thoroughly till the year 1737; and from this period they became every day more united, which gave much ſatisfaction to ſome courts, and no umbrage to any. In this ſituation of things, a treaty was made in 1750 with the court of Madrid, by which Nova Colonia, on the river of Plata, was yielded to his Catholic majeſty, to the great regret of the Portugueſe, as well on account of the value of that ſettlement, as becauſe they apprehended their poſſeſſion of the Braſils would by this action be rendered precarious. On the laſt of July the ſame year, this monarch, worn out by infirmities, deceaſed, in the 61ſt year of his age, and in the 44th of his reign.

43 Don Joſeph's excellent adminiſtration.

Don Joſeph, prince of Braſil, ſucceeded him, to the univerſal ſatisfaction of his ſubjects, and with as great expectations as ever any monarch that mounted the throne. It was generally believed that he would make conſiderable alterations, in which he did not diſappoint the hopes of the public; and yet they were done ſo ſlowly, with ſuch moderation, and with ſo many circumſtances of prudence, as hindered all grounds of complaint. Amongſt other new regulations, the power of the inquiſition ſuffered ſome reſtriction; the king directing, that none of their ſentences ſhould be put in execution till reviewed and approved by his privy-council. But as in the reign of his father he had conſented to the treaty with Spain, he ratified it after his acceſſion, and ſince carried it into execution upon this noble principle, that no conſiderations of intereſt ought ever to induce a monarch to break his word.

44 Dreadful calamities during his reign.

However, within the ſpace of the few years of this king's reign, the calamities of Portugal in general, and thoſe of the city of Liſbon in particular, cannot, in a great degree, be paralleled in all hiſtory. An earthquake, a fire, a famine, an aſſaſſination-plot againſt their prince, executions upon executions, the ſcaffolds and wheels for torture reeking with the nobleſt blood; impriſonment after impriſonment of the greateſt and moſt diſtinguiſhed perſonages; the expulſion of a chief order of eccleſiaſtics; the invaſion of their kingdom by a powerful, ſtronger, and exaſperated nation; the numerous

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rous troops of the enemy laying waſte their territory, bringing fire and ſword with them, and rolling like diſtant thunder towards the gates of their capital; their prince ready almoſt to ſave himſelf by flight! The Spaniſh miniſtry had already decreed the doom of Portugal, and nothing was to be heard at the Eſcurial but *Delenda eſt Carthago*. Carthaginian, perhaps, or Jewiſh ſtory, may poſſibly afford a ſcene ſomething like this, but for the ſhortneſs of the period not ſo big with events, though in their final deſtruction ſuperior. From that indeed, under the hand of Providence, the national humanity and generoſity of Great Britain has preſerved the Portugueſe; and it remains now to be ſeen, in future treaties, how that people will expreſs their gratitude (ſee BRITAIN, n° 450). Thoſe who are able to ſearch deeper into human affairs, may aſſign the cauſes of ſuch a wonderful chain of events; but no wiſe man will aſcribe all this to ſo ſingular a cauſe as that which a Spaniard has done, in a famous pamphlet, printed in the year 1762 at Madrid. It is intitled, *A Spaniſh Prophecy*; and endeavours to ſhow, that all theſe calamities have befallen the Portugueſe, ſolely on account of their connection with the heretic Engliſh. The great Ruler and Governor of the world undoubtedly acts by univerſal laws, regarding the whole ſyſtem, and cannot, without blaſphemy, be conſidered in the light of a partizan. The reſt of the pamphlet tends to ſhow, that his Catholic majeſty carried his arms into Portugal, ſolely to give them liberty, and ſet them free from Engliſh tyranny.

45 Theſe calamities fooliſhly accounted for.

Joſeph dying without male iſſue, the ſucceſſion devolved to Mary, his daughter, now queen of Portugal. She was married ſome time before he died, with the pope's diſpenſation, to his brother Don Pedro.

46 Air, climate, &c.

The air of Portugal, in the ſouthern provinces, would be exceſſively hot, if it were not refreſhed by the ſea-breezes; but in the northern, it is much cooler, and the weather more ſubject to rains. The ſpring is extremely delightful here; and the air, in general, more temperate than in Spain. Liſbon has been much reſorted to of late by valetudinarians and conſumptive perſons from Great Britain, on account of its air. The ſoil is very fruitful in wine, oil, lemons, oranges, pomegranates, figs, raiſins, almonds, cheſnuts, and other fine fruits; but there is a want of corn, owing, it is ſaid, in a great meaſure to the neglect of agriculture. There is plenty of excellent honey here; and alſo of ſea and river fiſh, and ſea-ſalt. The horſes in Portugal are briſk lively animals, as they are in Spain, but of a ſlight make: but mules being ſurer-footed, are more uſed for carriage and draught. By reaſon of the ſcarcity of paſture, there are not many herds of cattle or flocks of ſheep; and what they have are ſmall and lean, though the fleſh is tolerably good: their beſt meat is ſaid to be that of hogs and kids. The country in many parts is mountainous: but the mountains contain all kinds of ores; particularly of ſilver, copper, tin, and iron, with a variety of gems, beautifully variegated marble, millſtones, and many curious foſſils. Not far from Liſbon is a mine of ſaltpetre; but none of the metal mines are here worked, the inhabitants being ſupplied with metals of all kinds from their foreign ſettlements. The principal rivers are the Minho, in Latin *Minius*; the Limia, anciently the famed Lethe; the Cavado; the Douro; the Guadiana, anciently Anas; and the Tajo, or Tagus, which is the largeſt river in the kingdom, carrying ſome gold in its ſands, and falling into the ſea a little below Liſbon. There are ſeveral mineral ſprings in the kingdom, both hot and cold, which are much frequented.

Portugal.

47 Religion.

The only religion tolerated in Portugal is that of the church of Rome; yet there are many concealed Jews, and thoſe too even among the nobility, biſhops, prebends, monks, and nuns, and the very inquiſitors themſelves. If a Jew pretends to be a Chriſtian and a Roman Catholic, while he is really a Jew, by going to maſs, confeſſion, &c. or if after being converted, or pretending to be converted and pardoned, he relapſes into Judaiſm and is diſcovered, the inquiſition lays hold of him. In the firſt caſe, if he renounce Judaiſm, he is only condemned to ſome corporal puniſhment or public ſhame, and then ordered to be inſtructed in the Chriſtian religion. In the ſecond, he is condemned to the flames without mercy. Beſides Jews and heretics, who broach or maintain any doctrines contrary to the religion of the country, the inquiſition puniſhes all ſodomites, pretenders to ſorcery and the black art, apoſtates, blaſphemers, perjured perſons, impoſtors, and hypocrites. The burning of thoſe condemned by the inquiſition, is called an *auto da fe*, or "act of faith." There are ſeveral tribunals of the inquiſition, one of which is at Goa in the Eaſt Indies; but there are none in Braſil. The number of convents in Portugal is ſaid to be 900. The order of Jeſuits hath been ſuppreſſed in this country, as they have been in others. Here is a patriarch, ſeveral archbiſhops and biſhops: the patriarch is always a cardinal, and of the royal family. The archbiſhops rank with marquiſſes, and the biſhops with counts. The Portugueſe have archbiſhops and biſhops in the other quarters of the world as well as in Europe. The ſums raiſed by the popes here, by virtue of their prerogatives, are thought to exceed the revenues of the crown, and the nuncios never fail of acquiring vaſt fortunes in a ſhort time. Though there are two univerſities and ſeveral academies, yet while the papal power, and that of the eccleſiaſtics, continues at ſuch a height, true learning is like to make but a ſmall progreſs. The language of the Portugueſe does not differ much from that of Spain: Latin is the groundwork of both; but the former is more remote from it, and harſher to the ear, than the latter. The Portugueſe tongue is ſpoken on all the coaſt of Africa and Aſia as far as China, but mixed with the languages of the ſeveral nations in thoſe diſtant regions.

48 Manufactures.

With regard to manufactures, there are very few in Portugal, and thoſe chiefly coarſe ſilks, woollen cloths, and ſome linen; but their foreign trade is very conſiderable, eſpecially with England, which takes a great deal of their wine, ſalt, foreign commodities, and fruits, in return for its woollen manufactures, with which the Portugueſe furniſh their colonies and ſubjects in Aſia, Africa, and America. Their plantations in Braſil are very valuable, yielding gold, diamonds, indigo, copper, tobacco, ſugar, ginger, cotton, hides, gums, drugs, dying woods, &c. From their plantations in Africa, they bring gold and ivory, and ſlaves to cultivate their ſugar and tobacco plantations in Braſil. They have ſtill ſeveral ſettlements in the Eaſt Indies, but far leſs conſiderable than formerly. The Azores or Weſtern Iſles, Madeira, and the Cape de Verde iſlands, alſo belong to

Portugal. them; but a great part of the riches and merchandize brought from these distant countries becomes the property of foreigners, for the goods they furnish the Portugueſe with to carry thither. The king's fifth of the gold brought from Brasil amounts commonly to about 300,000 l. Sterling; so that the whole annual produce of gold in Brasil may be estimated at near 2,000,000 Sterling. Lisbon is the greatest port in Europe next to London and Amsterdam.

49 Constitution and government. As to the constitution of Portugal, it is an absolute hereditary monarchy. Both here and in Spain there were anciently cortes, states, or parliaments; but they have long since entirely lost their share in the legislature. For the administration of the civil government, there is a council of state, and several secretaries; for military affairs, a council of war; for the finances, a treasury-court; and for the distribution of justice several high tribunals, with others subordinate to them, in the several districts into which the kingdom is divided. The cities have their particular magistracy. The proceedings of the courts are regulated by the Roman law, the royal edicts, the canon law, and the pope's mandates. Like the Spaniards, they transact most of their business in the mornings and evenings, and sleep at noon. The nobility are very numerous, and many of them are descended from natural sons of the royal family. They are divided into high and low. The high consists of the dukes, marquisses, counts, viscounts, and barons, who are also grandees, but of different classes, being suffered to be covered in the king's presence, and having the title of *Dons*, with a pension from the royal treasury, to enable them the better to support their dignity: the king styles them *Illustrious* in his letters, and treats them as princes. A duke's sons are also grandees, and his daughters rank as marchionesses. The inferior nobility or gentry are termed *Hidalgos*, i. e. gentlemen: they cannot assume the title of *Don* without the king's licence.

50 Revenues of the king. The revenues of the crown, since the discovery of the Brasil mines, are very considerable; but the real amount can only be guessed at. Some have said that it amounts, clear of all salaries and pensions, to upwards of 3,000,000 Sterling; others make it a great deal less. Thus much is certain, that the customs and other taxes run excessively high. Besides the royal demesnes, the hereditary estates of the house of Braganza, the monopoly of Brasil snuff, the coinage, the money arising from the sale of indulgencies granted by the pope, the fifth of the gold brought from Brasil, the farm of the Brasil diamonds, the masterships of the orders of knighthood, and other sources, yield very large sums. The forces, notwithstanding, of this nation, both by sea and land, are very inconsiderable; their land-forces being the worst militia in Europe, and their navy of little importance. They would be an easy conquest to the Spaniards if they were not under the protection of Britain.

51 Orders of knighthood. There are several orders of knighthood here, *viz.* the order of Christ, the badge of which is a red cross within a white one, and the number of the commanderies 454. 2. The order of St James, the badge of which is a red sword in the shape of a cross. A great number of towns and commanderies belong to this order. 3. The order of Aviz, whose badge is a green cross in form of a lily, and the number of its commanderies 49. Though these three orders are religious, yet the knights are at liberty to marry. 4. The order of St John, which has also several commanderies. Portugal Portulaca.

The king's titles are, *King of Portugal and the Algarves, on this side and the other side the sea of Africa; Lord of Guinea, and of the navigation, conquests, and commerce, in Ethiopia, Arabia, Persia, India*, &c. The king's eldest son is styled *Prince of Brasil*. In the year 1749, pope Benedict XIV. dignified the king with the title of *His most faithful majesty*.

52 Character of the people. The Portugueſe are represented as inferior to the Spaniards both in person and genius: as extremely haughty, treacherous, and crafty in their dealings; much given to avarice and usury; and vindictive, malicious, and cruel. The meaner sort are said to be extremely addicted to thieving: notwithstanding, it must be owned, that they have shown themselves on many occasions a brave and warlike people. They are justly famed for their skill in navigation; and for the many discoveries they have made, both in the East and West Indies. The women here, and in other countries of the same degree of heat, are not so prolific as in the colder climates; but they are said to be very beautiful whilst young, though their complexion is somewhat upon the olive. Their eyes are very black and sparkling, and retain their brilliancy after all their other charms are gone. It is the fashion here, at present, as in most other countries, for the ladies to spoil and disfigure their skins and complexions with paints, and washes: but, though lively and witty, they are said to have a nice sense of female honour. Both men and women make great use of spectacles; often not so much to aid their sight, as to denote their wisdom and gravity. Their dress, like that of the Spaniards, never used to vary, especially among the men; but of late years, both men and women have given much into the French modes. The women, when they go abroad on foot, are wont to use long veils, which cover their heads, but leave their faces bare.

PORTUGALLICA TERRA, earth of Portugal; the name of a fine astringent bole, dug in great plenty in the northern part of Portugal.

PORTULACA, PURSLANE: A genus of the monogynia order, belonging to the dodecandria class of plants; and in the natural method ranking under the 13th order, *Succulentæ*. The corolla is pentapetalous; the calyx bifid; the capsule unilocular, and cut round. There are several species, but the two following are the most remarkable. 1. The oleracea, annual, or common culinary purslane, rises with herbaceous, low, succulent, branchy stalks, six or eight inches high, garnished with wedge-shaped, thick, succulent leaves, and small close-setting flowers. There are two varieties; one with deep green leaves, the other with yellow leaves; both of which rise from the same seed. 2. The anacampseros, perennial, or shrubby cape purslane, rises with a shrubby branchy stalk, about six inches high, with oval, gibbous, succulent leaves, and the stalks terminated by small clusters of red flowers. Both these plants are of a succulent nature: the first is an herbaceous annual, for culinary uses; and the second a shrubby perennial, raised by the curious for variety. They are both exotics of a tender quality, of the temperature of greenhouse or stove plants. The common culinary purslane is raised annually from seed for summer use, and is an excellent ingredient

Portumna ‖ Poſpolite

gredient in ſummer ſalads, but improper for winter on account of its cold moiſt nature. The plant being tender, muſt be raiſed either on a hot-bed or in a warm border; in which laſt it will not ſucceed before April or May. The ſhrubby ſort muſt be kept in the hot-houſe, in pots of a dry ſoil.

PORTUMNA, a town of Ireland, in the county of Galway and province of Connaught, is 74 miles from Dublin. The caſtle of Portumna, the ſeat of the Earl of Clanricarde, is at this place, and near it are the ruins of an ancient caſtle. There is alſo a garriſon for a troop of horſe and two companies of foot. The town is ſeated on the river Shannon, where it falls into Lough Derg. The monks of the Ciſtertian abbey of Dunbrody, in the county of Wexford, had for a long time a chapel here, dedicated to St Peter and St Paul; but having at length forſaken it, O'Madden, dynaſt of the country, gave it to the Dominican friars, who, with the approbation of the monks of Dunbrody, erected a friary here and a church, which they dedicated to the bleſſed Virgin and the original patron ſaints; at the ſame time they built a ſteeple, and all other neceſſary offices. Pope Martin V. granted a bull to confirm their poſſeſſions, dated 8th October 1426; and on the 23d of November following he granted indulgencies to all who had contributed to the building. The walls are ſtill nearly entire, and ſhow that the monaſtery of Portumna was by no means an ignoble ſtructure. The ancient choir is now the pariſh-church.

POSE, in heraldry, denotes a lion, horſe, or other beaſt, ſtanding ſtill, with all his four feet on the ground. See Hollingſhead's *Deſcription of Britain*, chap. xvi.

POSITIVE, a term of relation oppoſed to negative. It is alſo uſed in oppoſition to relative or arbitrary: thus we ſay, Beauty is no poſitive thing, but depends on the different taſtes of people.

Positive Degree, in grammar, is the adjective in its ſimple ſignification, without any compariſon.

Positive Electricity. In the Franklinian ſyſtem all bodies ſuppoſed to contain more than their natural quantity of electric matter are ſaid to be *poſitively* electrified; and thoſe from whom ſome part of their electricity is ſuppoſed to be taken away are ſaid to be electrified *negatively*. Theſe two electricities being firſt produced, one from glaſs, the other from amber or roſin, the former was called *vitreous*, the other *reſinous*, electricity.

POSPOLITE, in the military eſtabliſhment of Poland, is the name given to a kind of militia. It is the moſt numerous and the moſt uſeleſs of the Poliſh armies. It conſiſts of the gentry at large, who, in caſe of invaſion, are aſſembled by a regular ſummons from the king, with conſent of the diet. Every palatinate is divided into diſtricts, over each of which proper officers are appointed; and every perſon poſſeſſing free and noble tenures is bound to military ſervice, either ſingly or at the head of a certain number of his retainers, according to the extent and nature of his poſſeſſions. The troops thus aſſembled are obliged only to ſerve for a limited time, and are not under the neceſſity of marching beyond the limits of their country. They ſubmit to no diſcipline but ſuch as they like themſelves; and are very apt to mutiny if detained more than a fortnight in the place appointed them to meet in, without marching. The mode of levying and maintaining this army is exactly ſimilar to that practiſed under the feudal ſyſtem. At preſent, though it is almoſt totally unfit for the purpoſes of repelling a foreign enemy, it is yet a powerful inſtrument in the hands of domeſtic faction: for the expedition with which it is raiſed under the feudal regulations facilitates the formation of thoſe dangerous confederacies which ſuddenly ſtart up on the conteſted election of a ſovereign, or whenever the nobles are at variance with each other.

Coxe's Travels.

Poſſe ‖ Poſſeſſions

POSSE COMITATUS, in law, ſignifies the power of the county, or the aid and aſſiſtance of all the knights, gentlemen, yeomen, labourers, ſervants, apprentices, &c. and all others within the county that are above the age of 15, except women, eccleſiaſtical perſons, and ſuch as are decrepit and infirm.

This poſſe comitatus is to be raiſed where a riot is committed, a poſſeſſion kept upon a forcible entry, or any force of reſcue uſed contrary to the king's writ, or in oppoſition to the execution of juſtice; and it is the duty of all ſheriffs to aſſiſt juſtices of the peace in the ſuppreſſion of riots, &c. and to raiſe the poſſe comitatus, or to charge any number of men for that purpoſe.

POSSESSION, in law, is either actual, where a perſon actually enters into lands or tenements deſcended or conveyed to him; or where lands are deſcended to a perſon, and he has not yet entered into them. A long poſſeſſion is much favoured by the law as an argument of right, even though no deed can be ſhown, and it is more regarded than an ancient deed without poſſeſſion.

If he that is out of poſſeſſion of land brings an action, he muſt prove an undeniable title to it; and when a perſon would recover any thing of another, it is not ſufficient to deſtroy the title of the perſon in poſſeſſion without he can prove that his own right is better than his.

In order to make poſſeſſion lawful upon an entry, the former poſſeſſor and his ſervants are to be removed from off the premiſſes entered on: but a perſon by leaſe and releaſe is in poſſeſſion without making any entry upon the lands.

POSSESSION, in Scots law. See LAW, Part III. N° clxii. 11, &c.

Dæmoniacal Possession. (See DÆMON and DÆMONIACS.) In the third volume of the Mancheſter Tranſactions, there is a paper on *popular illuſions* or medical demonology by Dr Ferriar. He informs us in a note, that, on the 13th of June 1788, George Lukins of Yatton in Somerſetſhire was exorciſed in the temple church at Briſtol, and delivered from the poſſeſſion of ſeven devils by the efforts of ſeven clergymen. An account of his deliverance was publiſhed in ſeveral of the public papers, authenticated by the Reverend Mr Eaſterbrook, vicar of the temple church in Briſtol.—Dr Ferriar gives us the following particulars, extracted from this account, which we ſhall here inſert.

"Lukins was firſt attacked by a kind of epileptic fit, when he was going about acting Chriſtmas plays, or mummeries: this he aſcribed to a blow given by an inviſible hand. He was afterwards ſeized by fits; during which he declared, with a roaring voice, that he was the devil, and ſung different ſongs in a variety of keys. The fits always began and ended with a ſtrong agitation

Poſſeſſion || Poſt.

agitation of the right hand. He frequently uttered dreadful execrations during the fits. The whole duration of his diſorder was eighteen years.

"At length, viz. in June 1788, he declared that he was poſſeſſed by ſeven devils, and could only be freed by the prayers *(in faith)* of ſeven clergymen. Accordingly the requiſite force was ſummoned, and the patient ſung, ſwore, laughed, and barked, and treated the company with a ludicrous parody on the *Te Deum*. Theſe aſtoniſhing ſymptoms reſiſted both hymns and prayers, till a *ſmall, faint, voice* admoniſhed the miniſters to adjure. The ſpirits, after ſome murmuring, yielded to the adjuration, and the happy patient returned thanks for his wonderful cure. It is remarkable, that during this ſolemn mockery, the fiend ſwore 'by his infernal den,' that he would not quit his patient; an oath, I believe, nowhere to be found but in the Pilgrim's Progreſs, from which Lukins probably got it.

"Very ſoon after the firſt relation of this ſtory was publiſhed, a perſon, well acquainted with Lukins, took the trouble of undeceiving the public with regard to his pretended diſorder, in a plain, ſenſible narrative of his conduct. He aſſerts, that Lukins's firſt ſeizure was nothing elſe than a fit of drunkenneſs; that he always foretold his fits, and remained ſenſible during their continuance; that he frequently ſaw Lukins in his fits, 'in every one of which, except in ſinging, he performed not more than moſt active young people can eaſily do;' that he was detected in an impoſture with reſpect to the clenching of his hands; that after money had been collected for him, he got very ſuddenly well; that he never had any fits while he was at St George's Hoſpital in London; nor when viſitors were excluded from his lodgings, by deſire of the author of the Narrative; and that he was particularly careful never to hurt himſelf by his exertions during the paroxyſm.

"Is it for the credit of this philoſophical age, that ſo bungling an impoſture ſhould deceive ſeven clergymen into a public act of exorciſm? This would not have paſſed even on the authors of the *Malleus Maleficarum*; for they required ſigns of ſupernatural agency, ſuch as the ſuſpenſion of the poſſeſſed in the air, without any viſible ſupport, or the uſe of different languages, unknown to the demoniac in his natural ſtate."

POSSESSIVE, in grammar, a term applied to pronouns, which denote the enjoyment or poſſeſſion of any thing either in particular or in common: as *meus*, "mine;" and *tuus*, "thine."

POSSESSORY ACTION, in Scots law. See LAW, n° clxxxiii. 18.

POSSIBILITY, in law, is defined to be any thing that is altogether uncertain, or what may or may not be.

POSSIBILITY, alſo denotes a non-repugnance to exiſting, in any thing that does not any way exiſt.

POSSIBLE, is ſometimes oppoſed to real exiſtence, and is underſtood of a thing, which, though it actually does not exiſt, yet may exiſt; as a new ſtar.

POSSIDONIA, (anc. geog.) See POESTUM.

POST, a word derived from the Latin *poſitus*, "ſet or placed." It is uſed in ſeveral different meanings, but all of them referring either immediately or remotely to this primitive ſenſe of *poſition*. Thus the word Poſt ſignifies, 1. A ſtake or piece of timber ſet upright; 2. A ſtation, particularly a military ſtation; 3. An office or employment; 4. An operation in book-keeping; 5. A conveyance for letters or diſpatches; 6. A particular mode of travelling. Poſt.

POST, a ſtake or piece of timber ſet upright. Poſts are uſed both in building and in fencing ground. In brick-buildings much of the ſtrength of the fabric depends on the nature of the poſts; as it is through them that the ſeveral parts are ſuſtained and held together. The *corner poſts* are called the *principal poſts;* thoſe formed into breſſummers between principal poſts for ſtrengthening the carcaſe of the houſe are called the *prick-poſts*. Poſts which are to be ſet in the ground ought to be well ſeaſoned and coated to preſerve them from rotting; burning the downward end has been recommended as an excellent preſervative, but a coating of pitch or tar, particularly the late invented coal-tar, can be moſt ſafely relied upon. For the various uſes to which poſts may be applied, and the form and ſpecies of them fitteſt to be employed in each caſe, ſee the articles ARCHITECTURE, JOINING, GARDENING, HOUSE, FENCE, &c. In architecture and ſculpture POSTS are a term uſed to denote certain ornaments formed after the manner of rolls or wreathings.

POST, a ſtation, particularly a military ſtation.—Any place where perſons are ſet or placed upon particular occaſions may be termed a *poſt;* but the word in this view is now chiefly reſtricted to military operations, and means any place or ſituation where ſoldiers are ſtationed. Thus the detachments eſtabliſhed in front of the army are termed the *out-poſts*, the ſtations on the wings of the army are ſaid to be the *poſts of honour*, as being the moſt conſpicuous and moſt expoſed. But in the operations of a campaign, a poſt properly ſignifies any ſpot of ground capable of lodging ſoldiers, or any ſituation, whether fortified or not, where a body of men may make a ſtand and engage the enemy to advantage. The great advantages of good poſts, in carrying on war, as well as the mode of ſecuring them, are only learned by experience. Barbarous nations diſdain the choice of poſts, or at leaſt are contented with ſuch as immediately fall in their way; they truſt ſolely or chiefly to ſtrength and courage: and hence the fate of a kingdom may be decided by the event of a battle. But enlightened and experienced officers make the choice of poſts a principal object of attention. The uſe of them is chiefly felt in a defenſive war againſt an invading enemy; as by carrying on a war of poſts in a country where this can be done to advantage, the moſt formidable army may be ſo haraſſed and reduced, that all its enterpriſes may be rendered abortive. Indeed in modern times this is ſo well underſtood, that pitched battles have become much more rare than formerly, manœuvring and ſecuring of poſts being conſidered as the moſt eſſential objects in the conduct of a campaign; a change in the art of war much to the advantage of humanity; ſkill, conduct, and prudence, having thus obtained the aſcendency over brutal courage and mere bodily ſtrength. In the choice of a poſt, the general rules to be attended to are, that it be convenient for ſending out parties to reconnoitre, ſurpriſe, or intercept the enemy; that if poſſible it have ſome natural defence, as a wood, a river, or a moraſs, in front or flank, or at leaſt that it be

Poſt. be difficult of acceſs and ſuſceptible of ſpeedy fortification; that it be ſo ſituate as to preſerve a communication with the main army, and have covered places in the rear to favour a retreat; that it command a view of all the approaches to it, ſo that the enemy cannot advance unperceived and reſt concealed, while the detachment ſtationed in the poſt are forced to remain under arms; that it be not commanded by any neighbouring heights; and that it be proportioned in extent to the number of men who are to occupy and defend it. It is not to be expected that all theſe advantages will often be found united; but thoſe poſts ought to be ſelected which offer the greateſt number of them. See WAR, *Index*.

POST, an office or employment. This uſe of the word is probably derived immediately from the idea of a military ſtation; a poſt being uſed to expreſs ſuch offices or employments as are ſuppoſed either to expoſe the holder to attack and oppoſition, or to require abilities and exertion to fill them. Hence the term is uſed only for *public* offices, and employments under the government; and were ſtrict propriety of ſpeech always attended to, *poſts* would denote thoſe ſtations only in which duty muſt be performed. In common language, however, every *public* office or appointment, even though nominal and ſinecure, goes under the name of a *poſt*.

POST, an operation in book-keeping. Poſting in book-keeping means ſimply the transferring an article to the place in which it ſhould be put, and arranging each under its proper head. It is upon this that the whole theory of book-keeping is founded. The Waſte-book, which is the groundwork of all ſubſequent operations, records every tranſaction exactly in the order in which it occurs. From this the ſeveral articles are poſted, or transferred into the Journal, which in fact is but a kind of ſupplementary book to the Waſte-book. From the Journal they are poſted anew into the Ledger; in which a ſeparate place is appropriated for each perſon with whom tranſactions are carried on, and frequently for every ſeparate article about which the buſineſs is concerned. The particular mode according to which ſuch transferences are made, may vary according to the nature of the trade carried on; the object is the ſame in all, to place every article ſo as that its operations on the general ſtate of the buſineſs may be certainly known and diſtinctly traced. For a full account of the way in which this is done, ſee *BOOK-Keeping*.

POST, a conveyance for letters or diſpatches.

In the early periods of ſociety, communication between the different parts of a country is rare and difficult, individuals at a diſtance having little inclination or opportunity for mutual intercourſe: when ſuch communication is at any time found neceſſary, a ſpecial meſſenger muſt be employed. As order and civilization advance, occaſions of correſpondence multiply. In particular, the ſovereign finds it requiſite frequently to tranſmit orders and laws to every part of the kingdom; and for doing ſo he makes uſe of couriers or meſſengers, to whom he commits the charge of forwarding his diſpatches. But without ſtations in the way, where theſe couriers can be certain of finding refreſhment for themſelves and ſupplies of what may be neceſſary for carrying them forward, the journey, however urgent and important, muſt always be retarded, and in many caſes altogether ſtopped. Experience, therefore, ſoon pointed out the neceſſity of enſuring ſuch accommodations, by erecting upon all the great roads houſes or ſtations at convenient intervals, where the meſſengers might ſtop, as occaſion required, and where too, for the greater convenience, relays of freſh horſes ſhould always be in readineſs, to enable them to purſue their journey with uninterrupted diſpatch. Theſe houſes or ſtations were with great propriety termed *poſts*, and the meſſenger who made uſe of them a *poſt*. Though at firſt, it is probable, the inſtitution was intended ſolely for the ſovereign and the neceſſities of the ſtate; yet by degrees individuals, ſeeing the benefit reſulting from it, made uſe of the opportunity to carry on their own correſpondence; for which they were willing to pay an allowance to the ſovereign. Thus a poſt-office, of ſome kind or other, gradually came to be eſtabliſhed in every civilized country. Without taking notice of the different means of carrying on correſpondence ſaid to have been attempted by pigeons, dogs, and other animals, we can at leaſt trace with certainty the invention of ſomething like regular poſts as far back as the ancient Perſians. Xenophon aſſures us, that they were invented by Cyrus on his Scythian expedition, about 500 years before Chriſt; that the houſes at the ſeveral ſtations were ſumptuouſly built, and large enough to contain a number of men and horſes; and that every courier on his arrival was obliged to communicate his diſpatches to the poſtmaſter, by whom they were immediately forwarded. From the ſhore of the Egean ſea to Suſa the capital, there were, according to Herodotus, 111 ſtages for poſts, each a day's journey diſtant from the preceding.

In what manner poſts were eſtabliſhed and conducted among the Greeks does not clearly appear; but from the extended commerce carried on, and the frequent communications enjoyed among the different ſtates, there can be no doubt that a regular conveyance, in ſome form or other, was eſtabliſhed.

Though poſts were well known among the Romans, yet it is difficult to trace with certainty the period of their introduction. Some writers carry it back to the times of the republic; poſts and poſt-offices, under the names of *ſtatores* and *ſtationes*, having been then, it is ſaid, eſtabliſhed by the ſenate. Whether this was the caſe or not, Suetonius aſſures us that Auguſtus inſtituted poſts along all the great roads of the empire. At firſt the diſpatches were conveyed from poſt to poſt by young men who run on foot, and delivered the diſpatch to others at the next ſtage. By and by Auguſtus ſubſtituted, in room of theſe, horſes and chariots, both for the conveyance of diſpatches and the convenience of travelling. His ſucceſſors continued the ſame eſtabliſhment; to the maintenance of which every ſubject of the empire was obliged to contribute. Poſt-horſes are mentioned in the Theodorian code *de curſu publico*; but theſe were only the public horſes appointed to be kept there for the uſe of the public meſſengers, who before this inſtitution ſeized any that came in their way. At each poſt-ſtation, according to Procopius, 10 horſes and as many poſtilions were kept, and the uſual rate of their travelling was from five to eight ſtations a-day.

It is to be obſerved, however, that all theſe eſtabliſhments of poſts in ancient times were formed as much, if not more, for travelling ſtations, than for the mere

Poſt. conveyance of letters and diſpatches. This latter object, it is true, was thereby ſecured; but the epiſtolary correſpondence of antiquity was probably at no time ſo extenſive as to require or maintain poſt-offices on the footing of modern poſts, for the mere conveyance of letters. It is in later times only, when the extenſion of commerce and diffuſion of literature gave occaſion to frequent communication, that theſe eſtabliſhments are to be looked for.

The earlieſt inſtitution of *poſts* that occurs in modern hiſtory is about the year 807 by the emperor *Charlemagne*; who, having reduced under his dominion Italy, Germany, and a part of Spain, eſtabliſhed three public poſts at the public expence, to carry on the communication with theſe three provinces. The inſtitution of poſts, however, like many other inſtitutions of that emperor, dropped at his death, and for a conſiderable time afterwards no traces of any ſuch eſtabliſhment are to be found. We cannot indeed diſcover them with certainty ſooner than 1464, when that reſtleſs and ſuſpicious prince Louis XI. eſtabliſhed poſts in France, that he might be the ſooner advertiſed of all that paſſed in his own or the neighbouring kingdoms. He employed in this ſervice 230 couriers, who delivered the letters at the different ſtations, and in the various towns through which they paſſed in their courſe. Succeeding monarchs created at different times certain offices for the expreſs purpoſe of ſuperintending the poſts; but the frequent changes to which theſe offices were expoſed, prevented for a long time the eſtabliſhment of any regular ſyſtem of poſts in that kingdom; inſomuch that in 1619 the author of the life of the duke d'Epernon ſays the packet or letter-office was not yet ſet up in France. Former eſtabliſhments, it is probable, were ſolely for the uſe of the court, not for the general good of the nation. From France, the inſtitution gradually ſpread through ſeveral other parts of Europe. In Germany, Lewis Hornig aſſures us they were firſt introduced by Count Taxis, who ſettled them at his own expence; in acknowledgment for which the Emperor Matthias in 1616 gave as a fief the office of poſtmaſter to him and his deſcendants.

In England, the eſtabliſhment of poſts in ſome form or other appears as early as the reign of Edward III. but the notices concerning them are ſo vague, that no account can be given of them. In the reign of Edward VI. however, ſome ſpecies of poſts muſt have been ſet up, as an act of parliament paſſed in 1548, fixing the rate of poſt-horſes at one penny *per* mile: The poſt-horſes here referred to were, it is probable, chiefly for travelling, and the carriage of letters or packets only an occaſional ſervice. In 1581, we find in Camden's Annals mention made of a chief poſtmaſter for England being appointed.—How his office was managed, does not clearly appear; the limited ſtate of the correſpondence of the country, probably rendered it of trifling conſequence. King James I. originally erected a poſt-office, under the controul of one Matthew de Queſter or de l'Equeſter, for the conveyance of letters to and from foreign parts; which office was afterwards claimed by Lord Stanhope; but was confirmed and continued to William Frizel and Tho. Witherings, by king Charles I. in 1632. Previous to this time, it would appear that private perſons were in uſe to convey letters to and from foreign parts; all ſuch interference with the poſtmaſter's office is therefore expreſsly prohibited. King Charles, in 1635, erected a letter-office for England and Scotland, under the direction of the above Thomas Witherings. The rates of poſtage then eſtabliſhed were, two-pence for every ſingle letter for a diſtance under 80 miles; four-pence from 80 to 140 miles; ſix-pence above 140 miles. The allowance to the poſtmaſters on the road for horſes employed in theſe poſts was fixed at two-pence halfpenny *per* mile for every ſingle horſe. All private inland poſts were diſcharged at this time; and in 1637 all private foreign poſts were in like manner prohibited. The poſts thus eſtabliſhed, however, extended only to a few of the principal roads; and the times of tranſmiſſion were not in every caſe ſo certain as they ought to have been. Poſt.

Witherings was ſuperſeded for abuſes in the execution of his offices in 1640, and they were ſequeſtrated into the hands of Philip Burlamachy, to be exerciſed under the care and overſight of the king's principal ſecretary of ſtate. On the breaking out of the civil war, great confuſions and interruptions were neceſſarily occaſioned in the conduct of the letter-office: but it was about that time that the outline of the preſent more extended and regular plan ſeems to have been conceived by Mr Edmond Prideaux, who was afterwards appointed attorney-general to the commonwealth. He was chairman of a committee in 1642 for conſidering the rate of poſtage to be ſet upon inland letters; and ſome time after was appointed poſtmaſter by an ordinance of both houſes of parliament; in the execution of which office he firſt eſtabliſhed a *weekly* conveyance of letters into *all* parts of the nation. In 1653, this revenue was farmed for L. 10,000 for England, Scotland, and Ireland; and after the charge of maintaining poſtmaſters, to the amount of L. 7000 *per annum*, was ſaved to the public. Prideaux's emoluments being conſiderable, the common council of London endeavoured to erect another poſt-office in oppoſition to his; but they were checked by a reſolution of the houſe of commons, declaring that the office of poſtmaſter is, and ought to be, in the ſole power and diſpoſal of the parliament. This office was farmed by one Maubey in 1654. In 1656 a new and regular general poſt-office was erected by the authority of the protector and his parliament, upon nearly the ſame model that has been ever ſince adopted, with the following rates of poſtage: For 80 miles diſtance, a ſingle letter two pence; for a greater diſtance, not out of England, three pence; to Scotland, four pence. By an act of parliament paſſed ſoon after the reſtoration in 1660, the regulations ſettled in 1656 were re-eſtabliſhed, and a general poſt-office ſimilar to the former, but with ſome improvements, was erected. In 1663 the revenue of the poſt-office was found to produce L. 21,500 annually. In 1685 it was made over to the king as a branch of his private income, and was then eſtimated at L. 65,000 *per annum*. The year after the revolution the amount of the poſt-office revenue was L. 90,504 : 10 : 6. At the union the produce of the Engliſh poſt-office was ſtated to be L. 101,101. In 1711 the former eſtabliſhments of ſeparate poſt-offices for England and Scotland were aboliſhed; and by the ſtat. 9 Anne, c. 10. one general poſt-office, and one poſtmaſter-general, was eſtabliſhed for the whole united kingdom; and this poſtmaſter was empowered to erect chief letter-offices at *Edinburgh*, at Poſt.

Poſt. *Dublin*, at *New York*, and other proper places in America and the Weſt Indies. The rates of poſtage were alſo increaſed at this time as follows.—In England, for all diſtances under 80 miles 3 d.; above 80 miles 4 d. From London to Edinburgh 6 d. In Scotland, under 50 miles 2 d.; from 50 to 80 miles 3 d.; above 80 miles 4 d. In Ireland, under 40 miles 2 d.; above 40 miles 4 d.—By the above act all perſons, except thoſe employed by the poſtmaſter, were ſtrictly prohibited from conveying letters. That year the groſs amount of the poſt-office was L. 111,461 17s. 10d. The nett amount, on a medium, of the three preceding years, was, in the printed report of the commiſſioners, for the equivalent ſtated to be for England, L.62,000, and for Scotland L. 2000. In 1754 the groſs revenue of the poſt-office for Great Britain amounted to L. 210,663, in 1764 to L. 281,535, and in 1774 to L. 345,321.—The privilege of franking letters had been enjoyed by members of parliament from the firſt erection of the poſt-office; the original deſign of this exemption was, that they might correſpond freely with their conſtituents on the buſineſs of the nation. By degrees the privilege came to be ſhamefully abuſed, and was carried ſo far, that it was not uncommon for the ſervants of members of parliament to procure a number of franks for the purpoſe of ſelling them; an abuſe which was eaſily practiſed, as nothing more was required for a letter's paſſing free than the ſubſcription of a member on the cover. To reſtrain theſe frauds, it was enacted, in 1764, that no letter ſhould paſs free unleſs the whole direction was of the member's writing, and his ſubſcription annexed. Even this was found too great a latitude; and by a new regulation in 1784, no letter was permitted to go free unleſs the date was marked on the cover in the member's own hand-writing, and the letter put into the poſt-office the ſame day. That year the rates of poſtage were raiſed in the following proportions: an addition of 1 d. for a ſingle ſtage; 1 d. from London to Edinburgh; 1 d. for any diſtance under, and 2 d. for any diſtance above, 150 miles. An addition to the revenue of L. 120,000 was eſtimated to ariſe from theſe regulations and additional rates. In all the ſtatements of duties upon poſtage of letters given in this account, the rates mentioned are thoſe upon ſingle letters, double letters pay double, treble letters treble, an ounce weight quadruple poſtage; all above are charged by the weight in the ſame proportion.

About the year 1784, a great improvement was made in the mode of conveying the mails, upon a plan firſt ſuggeſted in 1782 by Mr John Palmer. Diligences and ſtage-coaches, he obſerved, were eſtabliſhed to every town of note in the kingdom; and he propoſed that government, inſtead of ſending the mails in the old mode, by a boy on horſeback, ſhould contract with the maſters of theſe diligences to carry the mail, along with a guard for its protection. This plan, he ſhowed, could not fail to enſure much more expeditious conveyance, the rate of travelling in diligences being far quicker than the rate of the poſt; and it was eaſy to carry it into execution with little additional expence, as the coach owners would have a ſtrong inducement to contract at a cheap rate for conveying the mail, on account of the additional recommendation to paſſengers their carriages would thereby acquire in point of ſecurity, regularity, and diſpatch.

Tho' government heartily approved of this plan, and the public at large were ſatisfied of its utility; yet, like all new ſchemes, however beneficial, it met with a ſtrong oppoſition: it was repreſented by a number of the oldeſt and ableſt officers in the poſt-office, not only as impracticable, but dangerous to commerce and the revenue. Notwithſtanding of this oppoſition, however, it was at laſt eſtabliſhed, and gradually extended to many different parts of the kingdom; and, upon a fair compariſon, it appeared that the revenue was improved, and the plan itſelf executed for L. 20,000 *per annum* leſs than the ſum firſt eſtimated by Mr Palmer.

The preſent eſtabliſhment of the general poſt-office for Great Britain, conſiſts of two poſtmaſters-general, a ſecretary, ſurveyor, comptroller-general, and upwards of 150 aſſiſtants and clerks for the head letter office in London; the number of deputy poſtmaſters and other officers through the kingdom is very conſiderable, but not eaſy to aſcertain with accuracy, as it muſt frequently vary with the changes made in the eſtabliſhment of country poſts. The total expence of this branch of the revenue in 1788 was L. 149,029, 17 s. 2 d. the groſs produce may now be reckoned at L. 650,000.

The firſt accounts we have of the eſtabliſhment of a poſt-office in Scotland reach no farther back than 1635, when Charles I. erected one both for Scotland and England. The poſt to Scotland by that appointment was to run night and day, to go from London to Edinburgh and to return in *ſix* days, taking with it all letters intended for any poſt-town in or near the road; the rate of poſtage from London to Edinburgh was 8 d. for a ſingle letter. The expedition with which the poſt went from London to Edinburgh at this time, is indeed ſurpriſing, conſidering the nature of the roads; perhaps, however, though the king made the regulation that it ſhould go and return in ſix days, the journey was not always performed in the ſpecified time. During the government of Cromwell, the public poſt conveyed letters to Scotland as well as England; the poſtage from London to Scotland was only 4d. After the Reſtoration, when the poſt-office was erected for England, mention is made in the act of parliament of the conveyance of letters to Scotland; and the poſtage to Berwick is fixed at 3d. For ſome time after, however, we find no eſtabliſhment by act of parliament of an internal poſt in Scotland. In 1662, a poſt between Ireland and Scotland was firſt eſtabliſhed; and the privy council gave Robert Main, who was then poſtmaſter-general for Scotland, an allowance of L. 200 Sterling to build a packet-boat for conveying the mail between Portpatrick and Donaghadee: the poſtage to Ireland was 6d. In 1669, a poſt was eſtabliſhed to go between Edinburgh and Aberdeen twice a-week, and between Edinburgh and Inverneſs once a-week: the rate of poſtage was fixed, for 40 Scots miles 2d. and for every 20 miles farther an additional penny. Theſe appear to have been the only *public* poſts in Scotland at that time; but as they could not ſuffice for the correſpondence of the country, there muſt have been more, either under the direction of the poſtmaſter, or in the hands of private perſons; probably there might be of both kinds. In 1690, an act for the ſecurity of the common poſt was paſſed, ſubjecting robbers of the mail to capital puniſhment. It was not till 1695 that the eſtabliſhment of the poſt-office in Scotland received the

Poſt. ſanction of parliament: poſts were then appointed for all parts of Scotland; the rates of poſtage were fixed, for any place within 50 miles of Edinburgh 2 d. between 50 and 100 miles 3d. all places above 100 miles 4 d. By the ſame act, a weekly packet to Ireland was eſtabliſhed, and L. 60 Sterling annually allowed for that ſervice. Though poſts were eſtabliſhed in conſequence of this act, yet ſuch was their mode of travelling, that they hardly deſerved the name. Thus, for inſtance, the perſon who ſet out to carry the mail from Edinburgh to Aberdeen, in place of ſtopping at the firſt intermediate ſtage from Edinburgh, and delivering over the mail to another, to be carried forward, went on with it himſelf the whole journey, reſting two nights by the way, firſt at Dundee, and next at Montroſe.

In this manner the mail was conveyed thrice a-week from Edinburgh to Aberdeen; but between moſt parts of Scotland the poſt went only twice, and between ſome only once a-week. The poſt-boy generally travelled on foot. Horſes were but little uſed in the ſervice of the poſt-office.

At the Union, the Scots poſt-office was farmed for L. 1194: in 1710, the nett amount for Scotland was reckoned to be L. 2000. The epiſtolary correſpondence of Scotland muſt have been ſmall indeed, when even the rates of poſtage then eſtabliſhed proved ſo very unproductive. This may perhaps, however, be in part accounted for, by conjecturing, that as private poſts had probably prevailed pretty much before 1695, it was long before theſe were entirely ſuppreſſed, the people ſtill adhering to their old conveyances, and difficulties occurring in ſtrictly enforcing the law; the amount of the poſt-office revenue, therefore, at the two periods above-mentioned probably exhibits a view of only a part of the correſpondence of Scotland.

In 1711, it has been already mentioned, one general poſt-office was eſtabliſhed for the whole united kingdom; but the poſtmaſter-general was authoriſed to erect at Edinburgh a chief letter office for Scotland.—This was accordingly done, and a poſtmaſter-general for North Britain, with other neceſſary officers, appointed. All the deputy poſtmaſters in Scotland are under his immediate direction, but he himſelf is under the controul of the poſtmaſter-general for Great Britain. From this head letter office poſts were eſtabliſhed to the different parts of Scotland.

For many years the poſt-boys generally travelled on foot, or if on horſeback, without a change of horſes. It was not till about 1750 that the mail began to be conveyed from ſtage to ſtage by different poſt-boys and freſh horſes to the principal places in Scotland, and by foot runners to the reſt. The communication between London and Edinburgh was at firſt but thrice a-week, and ſo ſlow, that the mail from London to Edinburgh was upon the road 85 hours, and from Edinburgh to London 131 hours. In 1757, upon a repreſentation from the royal boroughs, regulations were fallen upon, by which the time was ſhortened to 82 hours in the one caſe, and 85 in the other. By the extenſion of Mr Palmer's plan to Scotland, the time has been ſtill farther ſhortened to about 60 hours in each caſe.

The eſtabliſhment of the Scots poſt-office, which has been gradually enlarged as the ſtate of the country required, conſiſts at preſent of a poſtmaſter-general, ſecretary, ſolicitor, and accountant, with a number of other clerks and aſſiſtants for the head office at Edinburgh; under its management are about 180 deputy-poſtmaſters for the different poſt-towns through Scotland. Poſt.

The nett produce of the poſt-office for Scotland in 1733 was L. 5399, in 1754 L. 8927, in 1757 L. 10,623, in 1760 L. 11,942, in 1776 L. 31,103. In 1788 the groſs produce was L. 55,836, the expence L. 22,636, 13 s. 6 d.; in 1793 the groſs amount was about L. 64,000, the nett produce about L. 40,000.

Penny-Poſt, a poſt eſtabliſhed for the benefit of London and other parts adjacent, whereby any letter or parcel under 16 ounces weight, or L. 10 value, is ſpeedily and ſafely conveyed to and from all places within the bills of mortality, or within 10 miles of the city. It is managed by particular officers, and receiving houſes are eſtabliſhed in moſt of the principal ſtreets, for the more convenient tranſmiſſion of the letters. Some other large towns have inſtituted ſimilar eſtabliſhments.

About 20 years ago a penny-poſt was ſet up in Edinburgh by an individual, unconnected with the general poſt-office. It met with but indifferent encouragement for ſome years, doubts being entertained as to its punctuality in delivering the letters; by degrees, however, it ſeemed to be advancing in eſtimation, and was more frequently employed. About a year ago, the general poſt-office, in virtue of the act of parliament prohibiting the conveyance of letters by any but thoſe employed under the poſtmaſter-general, took the penny-poſt entirely into its own hands; and at preſent letters are tranſmitted from the general poſt-office to the different quarters of Edinburgh and the ſuburbs, three or four times a-day.

Poſt, a particular mode of travelling. A perſon is ſaid to *travel poſt*, in contradiſtinction to common journey travelling, when, in place of going on during his whole journey in the ſame vehicle, and with the ſame horſes, he ſtops at different ſtages, to provide freſh horſes or carriages for the ſake of greater convenience and expedition. As he thus uſes the ſame mode of travelling that is employed for the common poſt, he is ſaid to travel poſt, or in poſt, *i. e.* in the manner of a poſt.

In tracing the origin of poſts, it has been already remarked, that the more ancient eſtabliſhments of this kind were fully as much for *travelling ſtations* as the conveyance of letters. The relays of horſes provided at theſe public ſtations for the meſſengers of the prince, were occaſionally, by ſpecial licence, allowed to be uſed by other travellers who had ſufficient intereſt at court. Frequent demands of this nature would ſuggeſt the expedient of having in readineſs ſupplies of freſh horſes or carriages over and above what the *public* ſervice required, to be hired out to other travellers on payment of an adequate price. We find, therefore, that in former times the poſtmaſters alone were in uſe to let out horſes for riding poſt, the rates of which were fixed in 1548 by a ſtatute of Edward VI. at one penny *per* mile. In what ſituation the ſtate of the kingdom was with regard to travelling poſt for more than a century after this period, we cannot now certainly diſcover; but in the ſtatute re-eſtabliſhing the poſt-office in 1660, it is enacted, that none but the poſtmaſter, his deputies, or aſſigns, ſhall furniſh poſt-horſes for travellers; with a proviſo, however, that if he has them not ready in half an hour

Poſt. after being demanded, the traveller ſhall be at liberty to provide himſelf elſewhere.

The ſame prohibition is contained in the act eſtabliſhing the Scots poſt-office in 1695, as well as in the ſubſequent act of Queen Anne, erecting the general office for the united kingdom. It is doubtful, however, whether it ever was ſtrictly enforced. By an explanatory act of 26 Geo. II. the prohibition is confined to poſt *horſes* only, and every perſon declared to be at liberty to furniſh *carriages* of every kind for riding poſt. This regulation has, in fact, done away the prohibition, as hardly any perſon now thinks of travelling poſt except in a carriage.

The rate fixed by the act 1695, in Scotland, for a horſe riding poſt, was three-pence *per* Scotch mile. By the act 9 Anne, c. 10. three-pence a-mile without, and four-pence a-mile with, a guide, was the ſum fixed for each horſe riding poſt. The increaſe of commerce, and neceſſity for a ſpeedy communication between different parts of the kingdom, have brought the mode of travelling poſt ſo much into uſe, that upon every great road in the kingdom poſt-chaiſes are now in readineſs at proper diſtances; and the convenience of poſting is enjoyed in Britain to a degree far ſuperior to what is to be met with in any other country whatever.

Poſting at laſt appeared to the legiſlature a proper object of taxation. In 1779 the firſt act was paſſed, impoſing duties on horſes hired either by themſelves or to run in carriages travelling poſt: the duties were, one penny *per* mile on each horſe if hired by the mile or ſtage, and one ſhilling *per* day if hired by the day. Every perſon letting out ſuch horſes was alſo obliged to take out a licence at five ſhillings *per annum*. Theſe duties were next year repealed, and new duties impoſed, of one penny *per* mile on each horſe hired by the mile or ſtage, and 1s. 6d. on each if hired by the day. A number of additional regulations were at the ſame time enacted for ſecuring theſe duties. An addition of one halfpenny *per* mile, or three-pence *per* day, for each horſe riding poſt, was impoſed in 1785, by Stat. 25 Geo. III. c. 51. The duty is ſecured, by obliging every letter of horſes to deliver to the perſon hiring them a ticket, expreſſing the number of horſes hired, and either the diſtance in miles to be travelled, or that the horſes are hired by the day, as the caſe happens to be. Theſe tickets muſt be delivered to the bar-keeper at the firſt turnpike through which the traveller paſſes; and the turnpike-keeper gives, if demanded, what is termed an *exchange* ticket, to be produced at the next turnpike. The ſtamp-office iſſues to the perſon licenſed to let poſt-horſes ſuch a number of theſe tickets as is required, and theſe muſt be regularly accounted for by the perſon to whom they are iſſued. As an effectual check upon his account, the turnpike-keeper is obliged to return back to the ſtamp-office all the tickets he takes up from travellers. Evaſions are by theſe means rendered difficult to be practiſed without running a great riſk of detection. In 1787, for the more effectually levying the poſt-horſe duties, a law was paſſed, authoriſing the commiſſioners of the ſtamp-office to let them to farm by public auction, for a ſum not leſs than the produce in the year ending 1ſt Auguſt 1786.

In the advertiſement publiſhed by the commiſſioners in conſequence of this law, previous to the receiving propoſals for farming them, the total amount of the duty for Great Britain is ſtated to have been, at the period above referred to, L. 119,873. The ſum for which that duty was farmed in 1794 amounted in all to L. 140,030, of which the diſtrict of North Britain was L. 6000. Poſt.

Soon after the tax was impoſed, conſiderable difficulties were raiſed about the meaning of the term *poſting*, and what mode of journeying ſhould ſubject travellers to duty. The old law, Stat. 9 Anne, c. 10. explained poſting to be "travelling ſeveral ſtages, and changing horſes;" but the acts impoſing the poſting duties expreſsly declare, that "every horſe hired by the mile or ſtage ſhall be deemed to be hired to travel poſt, although the perſon hiring the ſame doth not go ſeveral ſtages upon a poſt road, or change horſes;" and that "every horſe hired for a day or leſs period of time, is chargeable with the duty of three halfpence *per* mile, if the diſtance be then aſcertained; and if the diſtance be not then aſcertained, with 1s. 6d. each horſe." Horſes hired for any leſs time than two days are by theſe acts to be deemed to be hired for a day. An action was brought in 1788, in the court of exchequer at Edinburgh, to determine whether ſeveral diſputed caſes fell under the meaning of the act, and were liable to duty; when the following deciſions were given:

Saddle-horſes both hired and paid by the mile, and ſaddle-horſes hired originally for an excurſion, but afterwards paid by the mile, were found liable to duty according to the number of miles paid for; carriage-horſes, where the carriage is hired and paid for only at the uſual rate of *outgoing* carriages, and no more, whether the perſon hiring it does or does not return in it, were found liable to duty only for the number of miles *out*; but if the carriage be hired and paid for, or actually paid for though not originally hired, at the uſual rate of carriages employed both to carry out and bring back the ſame company, the duty was found to be exigible according to the number of miles both out and home taken together. Hackney-coaches in Edinburgh, hired and paid for leſs than two miles, were found liable to duty for one mile.

No duty was found to be exigible on ſaddle-horſes hired for a mere excurſion, and paid for accordingly, where the diſtance neither is nor can be aſcertained; on hackney-coaches employed in the ſtreets for leſs than a mile, or for an excurſion or round of viſits merely; and on horſes or carriages hired for a journey of three days or more, and paid for accordingly, or paid for at the rate of three days, though the journey ſhould actually be performed in two full travelling days. The general rule of theſe deciſions was, that in every caſe, except unaſcertainable diſtance, or journeys exceeding two days, the mode of travelling fell under the legal definition of poſting. The only point that may ſeem doubtful in the judgments here ſtated, is that where the duty is found chargeable by the number of miles both going and returning. Yet as the law expreſsly declares, that horſes hired by the mile or ſtage are to be deemed *poſting*, and as the number of miles for which they are hired can only be aſcertained by the number paid for, it is clear, that where an addition to the outgoing charge is made on account of bringing back the perſon hiring the carriage, the carriage in that caſe is actually hired and paid for according to the number of miles both out and home, and the duty muſt fall to be rated accordingly.

Poſterior ‖ Poſture.

ingly. The doubtful points being now ſettled by the above deciſions, the mode of levying the duty in Scotland has been regulated agreeably to them ever ſince the matter was thus determined.

POSTERIOR, a term of relation, implying ſomething behind, or that comes after, another. In which ſenſe it is uſed in oppoſition to *prior* and *anterior*.

The back and hips are the poſterior parts of man. Ariſtotle has given prior and poſterior analytics. A date is poſterior to another, when it is later or freſher.

POSTERN, in fortification, a ſmall gate, uſually made in the angle of the flank of a baſtion, or in that of the curtain, or near the orillon, deſcending into the ditch; whereby the garriſon can march in and out, unperceived by the enemy, either to relieve the works, or to make private ſallies, &c.

The word is alſo uſed in the general for any private or back-door.

POSTHUMOUS, a child born after the death of his father, or taken out of the body of a dead mother; from whence it is frequently applied to the works of an author not publiſhed till after his deceaſe.

POSTIL, a name anciently given to a note in the margin of the Bible, and afterwards to one in any other book poſterior to the text.

POSTING, among merchants, the putting an account forward from one book to another, particularly from the journal or waſte-book to the ledger. See Post and Book-Keeping.

POSTLIMINIUM, among the Romans, the return of one who had gone to ſojourn elſewhere, or had been baniſhed, or taken by an enemy, to his own country or ſtate.

POSTPONING, putting any thing after or behind another with regard to time.

POSTSCRIPT, an article added to a letter or memoir, containing ſomething learnt or recollected after the piece was written.

POSTULATE, in mathematics, &c. is deſcribed to be ſuch an eaſy and ſelf-evident ſuppoſition, as needs no explication or illuſtration to render it intelligible; as that a right line may be drawn from one point to another.

POSTURE, in painting and ſculpture, the ſituation of a figure with regard to the eye, and of the ſeveral principal members thereof with regard to one another, whereby its action is expreſſed. A conſiderable part of the art of a painter conſiſts in adjuſting the poſtures, in giving the moſt agreeable ones to his figures, in accommodating them to the characters of the reſpective figures, and the part each has in the action, and in conducting and in purſuing them throughout.

Poſtures are either natural or artificial.

Natural poſtures are ſuch as nature ſeems to have had a view to in the mechaniſm of the body, or rather ſuch as the ordinary actions and occaſions of life lead us to exhibit while young, and while the joints, muſcles, ligaments, &c. are flexible.

Artificial poſtures, are thoſe which ſome extraordinary views or ſtudies occaſion us to learn; as thoſe of dancing, fencing, &c. Such alſo are thoſe of our balance and poſture maſters.

A painter would be ſtrangely puzzled with the figure of Clark (a late famous poſture-maſter in London) in a hiſtory-piece. This man, we are told in the Phil. Tranſ. had ſuch an abſolute command of his muſcles, &c. that he could diſjoint almoſt his whole body; ſo that he impoſed on the great ſurgeon Mullens, who looked upon him as in ſuch a miſerable condition, he would not undertake his cure. Though a well-made man, he would appear with all the deformities imaginable; hunch-backed, pot-bellied, ſharp-breaſted, &c. He diſjointed his arms, ſhoulders, legs, and thighs; and rendered himſelf ſuch an object of pity, that he has frequently extorted money, in quality of a cripple, from the ſame company in which he had the minute before been in quality of a comrade. He would make his hips ſtand a conſiderable way out from his loins, and ſo high as to invade the place of his back. Yet his face was the moſt changeable part about him, and ſhowed more poſtures than all the reſt. Of himſelf he could exhibit all the uncouth odd faces of a Quaker's meeting.

Potamogeton ‖ Potaſh.

POTAMOGETON, POND-WEED: A genus of the tetragynia order, belonging to the tetrandria claſs of plants; and in the natural method ranking under the 15th order, *Inundatæ*. There is no calyx; but four petals; no ſtyle, and four ſeeds There are 12 ſpecies, all of them floating vegetables on the ſurfaces of ſtagnant waters, affording an agreeable ſhade to fiſh, and food to cattle.

POTAMON or Potamo, was a philoſopher of Alexandria. He kept a middle courſe between the ſcepticiſm of the Pyrrhonians and the preſumption of the dogmatiſts; but attached himſelf to none of the ſchools of philoſophy of his time. He was the firſt projector of the Eclectic ſect; for though that mode of philoſophiſing had been pretty common before, he was the firſt that attempted to inſtitute a new ſect on this principle. "Diogenes Laertius relates, that not long before he wrote his Lives of the Philoſophers, an Eclectic ſect, ἐκλεκτικὴ τις αἵρεσις, had been introduced by Potamo of Alexandria, who ſelected tenets from every former ſect. He then proceeds to quote a few particulars of his ſyſtem from his Eclectic inſtitutes, reſpecting the principles of reaſoning, and certain general topics of philoſophical inquiry; from which nothing further can be learned, than that Potamo endeavoured to reconcile the precepts of Plato with thoſe of other maſters. As nothing remains concerning this philoſopher beſides the brief account juſt referred to in Laertius, an obſcure paſſage in Suidas, and another ſtill more obſcure in Porphyry; it is probable that his attempt to inſtitute a ſchool upon the Eclectic plan proved unſucceſsful. The time when Potamo flouriſhed is uncertain. Suidas places him under Auguſtus; but it is more probable, from the account of Laertius, that he began his undertaking about the cloſe of the ſecond century." *Enfield's Hiſtory of Philoſophy.*

POTASH, the lixivious aſhes of certain vegetables, uſed in making of glaſs, ſoap, &c. See Glass, Soap, &c.

Dr Shaw's method of making potaſh.

The method of making potaſh is directed by Dr Shaw as follows. Burn a quantity of billet-wood to grey aſhes; and taking ſeveral pounds of theſe aſhes, boil them in water, ſo as to make a very ſtrong lixivium, or ley. Let this ley be ſtrained through a coarſe linen cloth, to keep out any black parts of the half-burnt wood that might happen to remain in the aſhes; then evaporate this ſtrained lye in an iron-pan over a quick fire almoſt to dryneſs: then taking out the matter remaining

Potash.

maining at the bottom, and putting it into an iron crucible, ſet it in a ſtrong fire till the matter is melted, and then immediately pour it out upon an iron-plate, where it ſoon cools, and appears in the form of a ſolid lump of potaſh *. Much after this manner is pot-aſh made in the large way of buſineſs, for the ſervice of the ſoap-boiler, glaſs-maker, fuller, &c. but according to the difference of the wood, or combuſtible matter employed, with the manner of turning it, and conducting the proceſs, different kinds of potaſh are prepared. There are certain ſaline plants that yield this potaſh to great advantage, as particularly the plant kali; there are others that afford it in leſs plenty, and of an inferior quality, as bean-ſtalks, &c. but in general, all vegetable ſubjects afford it of one kind or other, and may moſt of them be made to yield it tolerably perfect after the manner of the proceſs already laid down, even the loppings, roots, and refuſe parts of ordinary trees, vine clippings, &c. The fixed ſalts of all vegetables excepting the kali and marine plants, when reduced to abſolute purity, or entirely ſeparated from the other principles, appear to be one and the ſame thing: whence it ſhould ſeem, ſays Dr Shaw, that by a ſuitable management, good ſaleable potaſh might be made in all places where vegetable matters abound. For if by examining Ruſſia (A) potaſh, for example, we find that its ſuperior excellence depends upon its being clear of earth, or upon its containing a large proportion of oil, or refined ſalt, theſe advantages may, by properly regulating the operation, be given to Engliſh potaſhes, ſo as perhaps to render the latter as good as the former: but where the potaſh of any remarkable ſaline vegetable is to be imitated, that of the kali, for example, the Doctor recommends a prudent ſprinkling of the ſubject with ſalt, or ſea-water, in the burning; and by theſe ways, peoperly diverſified, any principle that is naturally wanting might be artificially introduced ſo as to perfect the art of potaſh.

* See Pearl-*Aſh*, and *Tranſactions of the Royal Iriſh Academy*, 1789, art. 1. *Claſs* Science.

2 Account of Mr Stephen's manufacture.

About 40 years ago or upwards, Mr Stephens, encouraged by the Society of Arts, &c. and by a parliamentary grant of 3000 l. eſtabliſhed a manufacture of pot-aſh in North America, which produced ſuch as was ſo perfectly good as to anſwer in bleaching and other uſes the purpoſes of *pearl-aſh*; and which at the ſame time afforded a very large produce. But the very great heat which his proceſs required, occaſioned the deſtruction of a very extenſive apparatus; and other circumſtances concurred to diſappoint the hopes and check the ſpirit of the proprietors. The manufacture was, however, afterwards undertaken and proſecuted by others.

Plate CCCCXV.

Mr Stephens's apparatus was as follows: Fig. 1. A is the bed of the kiln, which ſlies off about four feet by two from the grate, more or leſs according to the ſize; C is the aſh-hole, 2½ or 3 feet deep. Fig. 2. B repreſents quadrangular bars of iron, with their oppoſite angles placed upwards and downwards, not above an inch aſunder. Fig. 3. A, B, and C, are three ſteepers five feet deep, and of any width from four to eight feet ſquare, of the beſt white pine or cyprus plank, with ſquare joints and ſtrong oak frames, placed each over a receiver, with a cock to let off the lye, and a vent juſt beneath the ſurface of the grating. E repreſents three receivers, ſtanding each under, and projecting out, from its ſteeper. They muſt be made of the beſt ſtuff, carefully put together, and laid in tough clay well rammed within the ground, their tops being level with the ſurface: they need not be ſo large as the ſteepers by ſix, eight, or twelve inches. Fig. 4. E repreſents a falſe bottom or lattice of boards, eight inches deep and five ſquare, with a hole in the under edge of every partition for the lye to paſs into the ſteeper. Fig. 5. A is the veſſel over the furnace in which the lye and aſhes are mixed; B is a hole or funnel a few inches from the back of the furnace, with an iron ſocket to let the pipe through the hinder part of the arch, to reach down within two inches of the floor of the furnace. C is a caſt iron cauldron for boiling the lye to dryneſs when pearl-aſh is made. D is a veſſel whence the liquor is let into the cauldron as it evaporates. The mortar for building the furnace ſhould be made of loam; the arch ſhould be 18 inches thick, and the floor ſhould be laid with tiles on a layer of ſand an inch thick, with neat joints.

Potaſh.

3 Of his apparatus.

4 Proceſs without uſing a kiln,

Mr Stephens's proceſs, both with and without the kiln, was as follows. Cut timber, felled at any ſeaſon, into lengths of about eight feet; lay from three to ten of them lengthwiſe in a heap upon dry ground, and fill the vacancies between with ſmaller wood: the ſooner it is burnt after felling, the better. Set fire to it by laying embers on the bottom logs at each end; and for burning the bruſh and lappings, with other ſmaller woods, lay them lengthwiſe on the ground, top to top, lapping over a little, with the butt ends outwards, and as cloſe as a faggot; laying the larger woods on top till the heap is full four feet high; the length of the bruſh ſet againſt each other making the breadth of the heap. As to the choice of the timber, old hollow trees, if not dead, are beſt: pine, cyprus, and cedar, are to be totally rejected.

As ſoon as the pile is burnt down, rake ſuch aſhes as lie round the outſide a little in towards the middle; add no freſh fuel, nor throw on any brands. Let the aſhes lie without ſtirring till you can juſt bear your hand in them; then carry them to a houſe, or under a ſhed, on a plank floor raiſed a little from the earth and well jointed;

(A) According to Sir Peter Warren, the beſt woods for making Ruſſia potaſh are, oak, aſh, poplar, hiccory, elm, hazle, and beech. They muſt be cut in November, December, January, and February, ſplit and ſtacked to dry. After 12 months in warm open weather, it muſt be burnt on a brick hearth by a ſlow fire in a kiln, or cloſe place; the aſhes muſt be ſifted through two ſieves, one finer than the other, and then put up in brick troughs or wooden backs, covered with rain or river water, and muſt remain well marſhed and incorporated five months. Brick furnaces ſhaped like bakers ovens muſt be heated with a ſtrong fire of oak or aſh, burning night and day; the prepared aſhes muſt be gradually thrown on the fire, when they will run into metal like lead: the fire muſt not go out till the furnace is nigh filled with potaſhes. The aſhes muſt then be broken to be taken out, but the larger the pieces the better; they muſt be preſerved from the air in tight caſks, the large pieces by themſelves, and the duſt by itſelf.

Potaſh. jointed; there wet them till brought nearly to the conſiſtence of mortar in the firſt mixture of lime and ſand, and ram them in a heap, in which they muſt lie full 20 days, or ſome months if you pleaſe; obſerving to be more ſparing of water in winter, and ramming them cloſer, and ſometimes wetting the top that it may never grow quite dry.

5 And with it. Plate CCCCXV. Wood may alſo be burnt in a kiln, as fig. 1 and 2; and then it muſt be cut into ſuch lengths as may be moſt convenient for carriage, and beſt ſuit the ſize of the kiln. The mouth of the aſh-hole muſt be cloſe ſtopped by daubing the joints of the lid with loam, or throwing a bank of ſand or earth againſt it: keep the bed of the kiln filled with wood up to the ſurface, but not above it, and let it burn inceſſantly till the aſhes riſe within ſix or eight inches of the grate. Draw them out whilſt red-hot, and in that ſtate ſprinkle them with lye, from four to ſix carats weight; weigh a ſmall vial which holds about four ounces very exactly; then fill it with water and weigh that alſo: divide the weight of water into equal parts till you come to $\frac{1}{128}$ of the whole, which is called a *carat*, $\frac{1}{64}$ two carats, &c. until you have a weight equal to $\frac{1}{4}$ of the whole water, which is called 32 carats: all which ſmall weights, together with one equal to the phial filled with water, are to be kept for weighing the lye in the ſaid phial till they are made damp; then ram them as before in a heap, but ſeparate from the aſhes made as above. N. B. By kiln-burning a ſtronger lye may be more certainly procured than by the other way, where rain may chance to fall on the aſhes before they can be removed.

The aſhes thus prepared are to be put in vats or ſteepers fig. 3, with a falſe latticed bottom as fig. 4; firſt putting coarſe wheat or rye ſtraw about a foot thick on the lattice or grating; on which put aſhes to within four or five inches of the top, ramming them all the way up, eſpecially at the ſides, with a ſmall light rammer, as tight as you can, without burſting the vat. Form on the top of the ſteeper a hollow baſon in the aſhes four or five inches deep, leaving the aſhes four or five inches thick on the ſides, by raiſing a ſmall bank round the ſides, ſo that the liquor may not overflow the edges of the aſhes at top: keep this baſon conſtantly filled with ſoft water in the ſteeper A, until the aſhes will imbibe no more, which will be in 24 hours or more, according as it is rammed; then turn the cock, and let off what ſhall be ſoaked through into the receiver or lower chamber of the ſteeper, and no more; for if the ſeveral runnings are not kept ſeparate, the lye will not be brought to its due ſtrength. Follow that ſteeper with freſh water on the ſame aſhes for ſeveral other runnings, which will each come off in a few days, till the liquor has neither ſmell nor taſte; then heave out the aſhes, and charge the ſteeper afreſh.

Upon drawing off the firſt running from the ſteeper A, fig. 3, fill the ſteeper B with aſhes as before, and put into its hollow at the top the lye ſo firſt run off, and the ſmaller or half lyes alſo, till full, and draw off as directed for the ſteeper A: if this weighs 18 carats or more, pump it into the ciſtern F as fit for uſe; if it be ſhort of that, paſs it off as half lye to the ſteeper C, and through freſh aſhes till ſtrong enough. With kiln-aſhes only, from water paſſing through the firſt ſteeper, it will be ſtrong enough for the ciſtern, if the aſhes are well prepared. If your water be hard, let it ſtand two or three days expoſed to the air and ſun in a ſhallow back, and it will be ſoft. When you uſe kiln-aſhes with others, lay them at bottom. Potaſh.

The lye muſt be conveyed from the ciſtern F, as it is wanted to the veſſel A fig. 5; where with every gallon of proof lye mix three ounces of fine, light, wood aſhes; and to the lye that is $\frac{1}{2}$ over-proof put ſix ounces of aſhes; and if $\frac{1}{3}$ over-proof 12 ounces, increaſing or leſſening according to the ſtrength of the lye.

For evaporating the lye and melting the ſalt, heat a furnace till you bring it very near a white heat, of which the ſide-doors being red-hot is a mark. This will take 48 hours or more, if the furnace be quite cold; when thorough hot, a little fuel keeps it ſo. Then, through the cock of the veſſel A, paſs the mixture by the funnel B into the furnace, not ſo as to reach much beyond the middle of the floor, before it changes from dark to bright red, letting the heat prevail towards front or back as you ſee neceſſary. When the maſs begins to gather about the flues or in heaps, run in no more till the furnace is cleared by driving the fire backward. You muſt have two funnels, one ſoon choaking: in an hour or leſs will iſſue out a red-hot ſtream of melted ſalt, which is potaſh, to be broke to pieces as ſoon as cold, and packed in tight cloſe caſks, being in no reſpect inferior to the beſt foreign aſh whatever.

6 Spaniſh potaſh the beſt. The beſt potaſh is made from barilla, and comes from Spain. The plants from which it is procured are found in great plenty about Carthagena, where they are indigenous, and may be collected in a ſwamp called *Almojar* eaſt of that place; the *Sayones* barilla is the beſt. They are found, beſides all along that coaſt, on the borders of the Mediterranean for 60 leagues in length and 8 in breadth. About 150,000 quintals of it are annually exported from Spain. It produces a revenue of 25,500l. a year; each quintal paying a duty of 17 reals: yet Don Bernardo de Ulloa, A. D. 1740, ſays it was farmed at L. 1822, 4s. 3d. M. Macdonnell has brought the manufacture of potaſh to its preſent perfection in Spain; but its exportation is materially injured by the heavy tax on it. See Townſhend's *Travels*, vol. iii. p. 131. See alſo BARILLA, KELP, and FUCUS.

7 Dr Percival's account of making potaſh. In the 70th volume of the Philoſophical Tranſactions we have an account of a method of procuring this ſalt from the putrid water which runs from dunghills. The proceſs is very eaſy, conſiſting only in ſimple evaporation of the fluid, and calcining the impure ſalt till moſt of the foulneſs is burnt out. From 24 wine-pipes full of this muck-water were obtained 9 cwt. 1 q. 12 lb of ſaleable potaſh, valued at 42 s. *per* cwt; the expence of manufacturing them being only valued at 4l. 9 s.

The potaſh thus made is of a greyiſh white appearance; deliqueſces a little in moiſt air; but if kept in a dry room, near the fire, acquires a powdery ſurface. It is hard and of a ſpongy texture when broken, with many ſmall cryſtals in its ſubſtance. The colour of its internal parts is duſky and variegated. To the taſte it is acrid, ſaline, and ſulphureous. It emits no ſmell of volatile alkali, either in a ſolid form, diſſolved, or when added to lime-water; neither does it communicate the ſapphire-colour to a ſolution of blue vitriol. Silver is quickly tinged black by it; a proof that it contains much phlogiſton. Ten grains of this potaſh required 11 drops of the weak ſpirit of vitriol to ſeparate it.

The

Potaſh. The like quantity of ſalt of tartar required 24 drops: a ſtrong efferveſcence occurred in both mixtures; and a ſulphureous vapour exhaled from the former. A tea ſpoonful of the ſyrup of violets diluted with an ounce of water was changed into a bright green colour by five grains of the ſalt of tartar; but ten grains of this potaſh were neceſſary to produce the ſame hue in a ſimilar mixture. Half an ounce of the ſalt diſſolved entirely in half a pint of hot water; but when the liquor was cold, a large purple ſediment ſubſided to the bottom; and it was found that this ſediment amounted to about two-thirds of the whole quantity of aſhes uſed.

Dr Percival, the author of this paper, concludes with obſerving, that this potaſh is a true fixed vegetable alkali, produced by putrefaction; that the quantity of alkali contained in it may be eſtimated at one-third of its weight, whereas the white Muſcovy aſhes are ſaid to yield only one-eighth part; that no quicklime appears to be contained in this potaſh, for a ſolution of it poured from its ſediment remained clear though long expoſed to the air: that it would be worth trying, whether the large purple ſediment, which ſubſides when this potaſh is lixiviated, might not be applied to the manufacture of Pruſſian blue, or uſed in the manner recommended by Macquer for dyeing wool and ſilks; and that this manufacture will furniſh the farmer for top-dreſſing for his garden and land, of great fertilizing powers. See *Phil. Tranſ.* Vol. LXX. p. 345.

8 Other attempts. Theſe are the proceſſes moſt eſſentially different from one another which have appeared concerning the manufacture of this uſeful ſalt. Some indeed have attempted to compoſe it on the ſuppoſition that alkali conſiſted of an earth combined in a peculiar manner with a certain acid. But the little ſucceſs of all theſe attempts ſhow that they have been built on a falſe principle. The only method of producing alkaline ſalts originally is from the aſhes of vegetables; and the vegetable ſubſtances which yield the largeſt quantity of them are tartar and marine plants. From the former the pureſt and ſtrongeſt vegetable alkali is obtained, and from the latter the mineral alkali. From other vegetables, as fern, broom, bean-ſtalks, &c. an alkaline ſalt is produced, but ſo impure, and in ſuch ſmall quantity, that no manufacture of it can be eſtabliſhed in this country with any reaſonable expectations of profit.

9 On extracting its alkaline part from rock-ſalt. Dr Watſon (the preſent biſhop of Landaff) ſuggeſts, that the inveſtigation of a method of extracting its alkaline part from rock ſalt would be a moſt ſerviceable diſcovery. We have inexhauſtible mines of rock ſalt in this country, which (he obſerves) the proprietors can afford at ten ſhillings a ton. A ton of rock-ſalt contains about half a ton of mineral alkali, which is for moſt purpoſes far preferable to potaſh. To thoſe who have leiſure to attempt ſuch a diſcovery, he gives the following hint: whether the alkaline part of rock-ſalt may not be obtained by calcining it in conjunction with charcoal in open fires? His reaſon for this conjecture is founded upon the following experiment: upon burning ſea-wreck to a black coal and ſtopping the proceſs at that point, he has obtained great plenty of common ſalt, but no mineral alkali from the black aſhes; though we are certain, that when the black aſhes are thoroughly calcined, or reduced to white aſhes, mineral alkali may be obtained from them. This makes it probable, that the common ſalt contained in the black aſhes of ſea-wreck is decompoſed, and changed into a mineral alkali, during the burning of the black aſhes. There are reaſons to ſuppoſe, that the cinder of pit-coal would anſwer the purpoſe better than charcoal. *Chem. Eſſ.* vol. i. p. 136, &c. Potaſh.

10 Dr Home's experiments on the potaſhes of different countries. The potaſhes of different countries vary much in quality; and the experiments of Dr Home, in his treatiſe on Bleaching, ſeem to ſet forth their different properties in the cleareſt point of view. The different kinds tried by him were,

1. *Blue pearl-aſhes.* Theſe appear to be a pure alkaline ſalt, mixed with a ſmall quantity of vitriolated tartar and earth. Half a pound of this, filtered and evaporated, yielded 5½ ounces of pure ſalt.—Here, however, we muſt obſerve, that though the quantity was ſo far diminiſhed by this operation, yet we are not to imagine that the whole of this diminution was owing to impurities; for all ſalts are deſtroyed in ſome meaſure by ſolution in water and exſiccation.

2. *White pearl-aſhes* are nearly of the ſame quality with the former; half a pound of them giving five ounces and ſeven drams of pure ſalt, with ſome vitriolated tartar and earth.

3. *Ruſſia* or *Muſcovy aſhes* have very much the appearance of ſlacked lime, and are, like it, friable betwixt the fingers. They adhere to the tongue; and their alkaline taſte ſoon goes away, leaving in the mouth a ſtrong taſte of lime. Some ſmall bits of charcoal are obſervable in their compoſition, and they never turn moiſt in the air. Half a pound of the ſalt lixiviated with water and evaporated, gave only 10 drams 15 grains of very cauſtic ſalt. Theſe conſiſt therefore of a ſmall quantity of alkaline ſalt united with a large quantity of lime.

4. *Caſhub-aſhes* are of the colour of iron ſtone, and extremely hard, with many ſhining particles of charcoal in them. They have a ſaline taſte, with a conſiderable degree of pungency; feel gritty in the mouth when broke in pieces by the teeth; and will diſſolve in water. To extract the pure ſalt, half a pound of the aſhes were boiled in a pint of water; then that water poured off, and half a pint put on the aſhes again; and ſo on, till the aſhes taſted no more ſalt. This boiling took 24 hours, and the laſt water that came off had a ſtrong taſte of ſulphur, and was blackiſh. A piece of ſilver put in the decoction was in a few minutes turned almoſt black; but though the decoction was evaporated conſiderably, it did not turn ſilver black more ſpeedily than before. The whole, when totally evaporated, yielded only 10 drams of a brown ſalt having a ſtrong cauſtic alkaline taſte. Some Caſhub-aſhes powdered, and often waſhed in water ſo that the ſalts were all carried off, were infuſed in water. After ſtanding ſome time, there was a weak lime-water, with ſomething of a ſaline taſte, but no pellicle. Some of this reſiduum was put into a reverberatory furnace for two hours; after which it afforded good lime-water. Caſhub-aſhes then appear to contain an earth half vitrified, ſome lime, alkaline ſalts, and a quantity of ſulphur.

5. *Marcoſt aſhes* are of a paler colour than the former, with ſome ſmall pieces of charcoal in their compoſition. They have a ſtrong faline taſte; and ſo great pungency, that they cannot be held long in the mouth. Half a pound diſſolved in water, filtered and evaporated, yielded 11 drams one ſcruple and two grains of alkaline

Potash.

kaline reſiduum. The decoction blackened ſilver, but not ſo ſtrongly as the former; and by evaporation it quickly loſt that quality.

II On manufacturing them in this country.

Our author next proceeds to conſider the probability of manufacturing theſe aſhes in this country. On which ſubject he has the following obſervations.—— "The blue and white pearl-aſhes we have diſcovered to be pure alkaline ſalts, without any conſiderable mixture of heterogeneous bodies. Their purity ſhows the lixive to have been ſtrained through ſome cloſe ſubſtance, ſuch as linen or flannel. The blue aſhes ſhow by their colour that they have ſuſtained the moſt fire. But both of them are ſo much alike, that the one may be ſubſtituted for the other; and therefore we ſhall conſider them in one view.

"Every one knows that alkaline ſalts, ſuch as theſe, are got from all plants except the alkaleſcent, and from all trees except the moſt reſinous, which afford them in very ſmall quantity. Theſe plants or trees, when found, are pulled or felled in the ſpring, dried, and burnt to aſhes. By the affuſion of warm water the ſalts are diſſolved, and, by ſtraining, ſeparated from the earth along with the water. This ſaline liquor, which is called a *lixive*, is evaporated over a fire; and what remains is an alkaline ſalt of the ſame kind with the pearl-aſhes.

"I was informed by a ſkilful bleacher in Ireland, that he practiſed a more expeditious way of extracting the ſalts. He bought the aſhes of different vegetables from the commonalty for 9 s. a buſhel. From theſe a very ſtrong lye was made, into which dry ſtraw was dipped until it ſucked up all the lye. This ſtraw was afterwards dried and burnt, and gave him ſalts which he ſhowed me, almoſt as good and pure as the pearl-aſhes. This method I have ſeveral times tried; but could never burn the ſtraw to white aſhes, the ſalts diminiſhing the inflammability of the ſtraw. It is a very expeditious method if it can be practiſed. But I can ſee no occaſion for bringing the lye into a ſolid form, as the ſalts muſt again be diſſolved in water before they can be uſed. The ſtrength of the lye can eaſily be determined by the hydroſtatical balance.

"Though I make no queſtion, that the quantity of ſalt, in plants of the ſame ſpecies, will vary in different ſoils and climates; yet it would be of advantage to have the proportion aſcertained in general. Some trials of this kind I have made.

"Two pounds of fern which had been pulled Auguſt 16. were dried, and burnt to white aſhes. Theſe weighed 7 dr. and taſted very ſalt. When lixiviated, ſtrained, and evaporated, they gave me 49 gr. of ſalt, about the eighth part of the aſhes. If the fern had been pulled in April, it would have afforded more ſalt. Why then ſhould we not prepare ſalts from this vegetable? There is more of it growing on our hills than would ſerve all our bleachfields. The Iriſh make great uſe of it.

"From 11 oz. of tobacco-aſhes I had 1 oz. of ſalt. Two ounces of peat-aſhes afforded half a drachm of ſalt. Nettles, I am informed, afford much ſalt. Furz and broom, natives of this country, are very fit for this purpoſe. Potash.

"But the kelp, as it grows in ſuch plenty along our ſhore, and contains more ſalt than any other vegetable I know, would be the moſt proper, were it not for a mixture of ſome ſubſtance that renders it unfit for bleaching, at leaſt of fine cloths, after they have obtained a tolerable degree of whiteneſs. It is obſerved by bleachers, that, in theſe circumſtances, it leaves a great yellowneſs in the linen. As theſe aſhes are much uſed in Ireland, and as it is not uncommon to bleach coarſe cloths with them in Scotland, a diſquiſition into their nature, and ſome attempts to purify them, may not be improper. There are no aſhes ſold ſo cheap as theſe; for the beſt gives but 2 l. the 2000 weight (B). They may, therefore, allow of more labour to be expended on them, and come cheaper at long-run than the foreign ſalts.

"I dried ſome ſea-ware, and burnt it, though I found that laſt operation very difficult. When I had kept it fuſed in the fire for two hours, it weighed $3\frac{1}{2}$ oz. I poured on the aſhes an Engliſh pint and a half of cold water, that I might have as little of the ſulphur as poſſible. This lye, after it had ſtood for ſome hours, was poured off clear, and had but a ſlight tendency to a green colour. I made a ſecond infuſion with milk-warm water, and poured it off from the ſediment. This had a darker colour than the former; was kept ſeparated from it, and evaporated by itſelf. There was a third infuſion made; but having no ſalt taſte, it was thrown away. The ſecond infuſion ſeemed to contain more ſulphur than the firſt; and a piece of white linen kept in it half an hour, while it was boiling, was tinged yellow, and could not be waſhed white again. The earthy part remaining, weighed, when well dried, 1 oz. 2 dr. The ſaline decoction evaporated by degrees, and ſet at different times in a cellar to cryſtallize, afforded me 5 dr. 46 gr. The liquor, when entirely evaporated, left $4\frac{1}{2}$ dr. of a yellow ſalt, which appeared to be a ſtrong alkaline. The ſalts which cryſtallized ſeemed to be moſtly ſea-ſalt, with a conſiderable quantity of ſulphur, and ſome alkaline ſalt. There appeared no ſigns of the bittern in theſe ſalts, as their ſolution did not turn turbid with the oil of tartar. Nor is any of the bittern to be expected in kelp aſhes, although it probably is to be found in the recent vegetable; becauſe the alkaline ſalts formed by the fire muſt have changed it into a neutral. The lye made warm with water, being evaporated, left 4 dr. of a black bitter ſalt, which, from its quantity of ſulphur, appeared unfit for bleaching. Theſe aſhes, then, ſeem to be a compoſition of ſomewhat leſs than the fourth of ſulphur, the ſame quantity of ſea-ſalt, about a fourth of alkaline ſalt, and ſomewhat more than a fourth of earth. The alkaline ſalt contained in kelp aſhes amounts to one penny a pound. This cheapneſs makes it worth our pains to beſtow ſome labour on them.

"If the bad effects in bleaching with kelp-aſhes ariſe

(B) "Since this treatiſe was written, however, the price of kelp has been advanced to 7 l. or upwards the 2000 weight; ſo that thoſe who would now attempt any thing of this kind, muſt alſo manufacture the kelp themſelves."

Potaſh. from the ſea-ſalt, as ſome of the moſt knowing bleachers think, they can be freed from it in an eaſy manner. Let a lixive of kelp-aſhes be made with cold water, for that does not extract ſo much of the ſulphur; it muſt ſtand but for a ſhort time, for theſe ſalts diſſolve eaſily; decant it, and evaporate the lye. As the boiling continues, the ſea-ſalt will cryſtallize. When that is all ſeparated, the remaining lye will contain alkaline ſalt with ſome ſulphur. This operation every maſter of a bleachfield may learn and overſee, without taking up much of his time. A ſimilar proceſs is carried on by common ſervants in the alum-works, who have by practice learned it from others.

"I had ſome hopes that the ſulphur might be carried off by long roaſting, ſuch as theſe ſalts undergo before they are fuſed in order to be turned into glaſs; becauſe I had obſerved, that the longer time they were kept in the fire, the freer were they from this ſulphureous part.

"I ordered a quantity of kelp aſhes to be kept in the furnace of a glaſshouſe, where the heat was juſt below the vitrifying point, for 24 hours. During this time they had loſt almoſt four-fifths of their weight. They were now much freer from their ſulphur, and were of a light colour; but much of the alkaline ſalt had been driven off with the oils. If a lye is much impregnated with this ſulphureous matter, it appears to be carried off in a great meaſure by long boiling.

"We come now to explain the method of manufacturing the white Muſcovy aſhes. We have ſhown, by undoubted experiments, that the greateſt part of theſe aſhes conſiſts of lime; and yet we have ſeveral acts of parliament which forbid the uſe of that material under ſevere penalties. The parliament were in the right to diſcharge its uſe, upon the diſadvantageous reports which were made to them. We ſhall immediately ſee how dangerous a material it is when uſed improperly, or without the mixture of alkaline ſalts, which render it ſafe, and more ſoluble in water. But I will venture to ſay, that experiment will not ſupport the prejudice entertained with regard to it, if carried any further.

"Since bleaching, then, cannot be carried on without it (for thoſe aſhes which contain it are quite neceſſary in that operation), and ſince we import them from foreign countries, let theſe prejudices againſt it ceaſe, and let us only conſider how we may render our own lime as ſafe as the foreign. If we can do that, the wiſdom of the legiſlature will be as ready to abrogate theſe acts as they were to make them.

"By my experiments on the white Muſcovy aſhes, I got about the eighth part of alkaline ſalts from them. This made me expect, that, by mixing in the ſame proportion quicklime and alkaline ſalts, I ſhould be able to produce Muſcovy aſhes.

"To an ounce of quicklime and a drachm of white pearl aſhes, I added about a gill of water, and boiled them together till the water was all evaporated. The taſte of this ſubſtance was little different from lime. To recover the ſalts again from the lime, I diſſolved it in water, ſtrained off the liquor, and evaporated it. Inſtead of the drachm of ſalts, I had but 2 gr. of a ſubſtance which was more earthy than ſaline.

"To 3 dr. of quicklime, and as much potaſhes, I added a mutchkin of water, and kept it boiling for two hours till it was evaporated. I diſſolved it again in water, which being filtered and evaporated, gave me 1½ dr. of a cauſtic ſalt, that liquefied in the air when it had been but four minutes from the fire. It appears, then, that the alkaline ſalts are deſtroyed by lime, and that a great part of them can never be again recovered. From the remaining lime, after the ſalts were extracted, I got ſtrong lime-water, but without a pellicle. This ſhows, that a quantity of alkaline ſalts, equal to the lime, boiled with it for two hours, are not able to fix all the ſoluble part of the lime. Potaſh.

"From theſe experiments we may draw ſome corollaries with regard to the preſent ſubject. 1*ſt*, That evaporating the water from the lime and ſalts by boiling, is a moſt unfrugal way of preparing theſe white aſhes. 2*dly*, That theſe aſhes ought to be kept cloſe ſhut up in caſks; for if expoſed to the open air, though in a room, the alternate moiſture and drought muſt fix their moſt uſeful parts. This I have found to be fact: for the ſalts that I made became leſs pungent by keeping; and I have obſerved, that the ſurface of the Muſcovy aſhes loſt all pungency by being expoſed to the air, while their internal parts ſtill retained it. 3*dly*, That all boiling is prejudicial to theſe Muſcovy aſhes, as it fixes, and that quickly, their moſt ſubtile and probably their moſt ſerviceable parts.

"Let us now proceed to another method of making theſe white aſhes. I imagined, that if the ſalts were diſſolved in water, and the quicklime ſlacked with that, the maſs would ſoon dry without the aſſiſtance of fire. In this way I added equal parts of both; but the compoſition was ſo ſtrong, that it bliſtered my tongue if it but touched it. When the fourth part was alkaline ſalt, it bliſtered my tongue when kept to it a few ſeconds. I could taſte the ſalts plainly in the compoſition, when they made but the thirty-ſecond part of the whole.

"I thought, when compoſed with the eighteenth part of ſalt, it had, when freſh made, juſt the taſte and look of the Muſcovy aſhes; nor could any perſon have diſtinguiſhed them. This I once imagined was the proportion; but when I found that the ſaline pungency ſoon turned weaker by keeping, and that this compoſition would not afford the ſame quantity of ſalts that the Muſcovy aſhes did, I ſaw that a much greater quantity of ſalts was neceſſary. The proportion appears to be one of ſalt to four of lime, prepared in this laſt way. Three drachms of aſhes prepared in this way, and kept for a fortnight, gave me but 15 grains of ſalt; which is but the half of what the Muſcovy would have afforded. I find, if the quicklime is firſt quenched, it does not fix the ſalts ſo much; and therefore is better and cheaper. One drachm of potaſhes diſſolved in a little water, and added to 3 drachms of quenched lime, gave me 44 grains of a very cauſtic ſalt. I prefer this method as the beſt.

"The manufacturers of this ſalt probably pour the lixive upon the lime, as they can know by its ſpecific gravity what quantity of ſalts is in the water, and ſo ſave themſelves the expence of procuring the ſalts in a dry form.

"The manufacture of the Marcoſt and Caſhub aſhes remains yet to be explained. We have diſcovered that both of them contain ſulphur, earth, alkaline ſalts, and

Potaſh. lime; and differ in nothing but in the Caſhub's having more ſulphur than the Marcoſt aſhes. We ſhall therefore conſider them together.

"Whether theſe two ſpecies of aſhes are of any uſe in bleaching, may be, and has already been, diſputed. I find they contain no other principles, the ſulphureous part excepted, than the former aſhes combined together. Why then ſhould we expect any other effects from the ſame ingredients in the Marcoſt and Caſhub aſhes, than what we have from either of the pearl and Muſcovy aſhes mixed together? The ſulphureous principle in the former muſt have very bad effects; as I find by experiment, that it leaves a yellowneſs on cloth that is very hard to be waſhed out. It is owing to this ſulphureous principle that linen, after it has been waſhed with ſoap, and is pretty well advanced in whiteneſs, is apt to be diſcoloured by lye which is brought to boil: for, by boiling, the ſulphureous part is extracted from theſe aſhes, and the lye becomes of a deep brown colour. Daily practice, then, ſhows the diſadvantage of this ſulphureous principle. Beſides, as ſulphur unites itſelf quickly and firmly with alkaline ſalts, it muſt weaken or altogether deſtroy a great quantity of theſe in the Marcoſt and Caſhub aſhes, and ſo render them of no effect in bleaching. Theſe two reaſons ſeem to me ſufficient to exclude them from the bleachfield; eſpecially as, by increaſing the other materials, we can attain perhaps more ſpeedily the ſame end.

"However, as cuſtom has introduced them into general practice, we ſhall conſider how they are to be manufactured. Dr Mitchell has, in a very ingenious and uſeful paper, contained in the Philoſophical Tranſactions for the year 1748, delivered an account tranſmitted to him by Dr Linnæus of the method of making potaſhes in Sweden. This account was contained in an academical diſſertation of one Lundmark upon this ſubject at Aboe in Sweden. The ſubſtance of this account is, 'That birch or alder is burnt by a ſlow fire to aſhes, and made into a paſte with water. This paſte is plaſtered over a row of green pine or fir logs. Above that is laid tranſverſely another row of the ſame; and that likewiſe is plaſtered over. In this way they continue building and plaſtering till the pile be of a conſiderable height. This pile is ſet on fire; and whenever the aſhes begin to run, it is overturned, and the melted aſhes are beat with flexible ſticks, ſo that the aſhes incruſt the logs of wood, and become as hard as ſtone.' This, in the Doctor's opinion, is the method of making the potaſhes that come from Sweden, Ruſſia, and Dantzic: and that there is no other difference betwixt the aſhes made in thoſe different countries, but that the Ruſſian, containing more ſalt, muſt be made into a paſte with a ſtrong lye.

"There would appear, by my experiments, a greater difference than this betwixt the Swediſh aſhes, if that is the true proceſs, and thoſe I have examined. I had diſcovered the greateſt part of the Muſcovy aſhes to be lime. I ſuſpected it might enter into the compoſition of the Marcoſt and Caſhub; and have accordingly diſcovered it there. Without the ſame grounds, none would ever have ſearched for it. Whence then comes this lime? It muſt either enter into its compoſition, or ariſe from the materials managed according as the proceſs directs.

"I have tried the birch aſhes made into a paſte with water. I have tried common charcoal made into a paſte with a third part of potaſhes, and kept them in a ſtrong reverberatory heat for ſome hours, and yet no ſuch cauſtic ſubſtance appeared. I have kept earth and ſalts of kelp-aſhes fuſed together for 24 hours in the furnace of a glaſshouſe, where the heat was juſt below the degree of vitrification; and yet no remarkable cauſticity appeared afterwards in the concreted maſs. But ſuppoſing that there did, will ever this account for the generation of lime? Theſe chemiſts do not aſſert that it is a calcareous cauſticity. The earth of vegetables kept in fuſion with their ſalts, is ſo far from turning into a quicklime, that the maſs takes the oppoſite courſe, and becomes glaſs. Bodies that, by the laws of nature, are vitreſcible, can never, ſo far as we know, become calcareous. In one or other of theſe two ſubſtances all bodies terminate that are changeable by fire; and vegetables are of the former kind. Here it may be aſked, Why then, ſince they endure ſuch a fire, are they not vitrified? the objection would be juſt, did they contain nothing elſe but what was found in vegetables. But if we once allow that lime is one of the materials, the difficulty is eaſily ſolved: for lime, we know, in proportion as it is mixed, hinders the vitrification of all bodies. In effect, the earthy part in theſe aſhes is almoſt vitrified: and I think that I have carried the vitrification yet farther in that part; but I never was able, with the utmoſt heat of a reverberatory furnace, continued for ſix hours, to produce any thing like a thorough vitrification in theſe aſhes. The heat of the fire uſed in the proceſs would ſeem to be very great; and muſt, if it were not very difficult, reduce them to glaſs. The invitreſcible nature of theſe ſalts, ſo far from being an objection, becomes a ſtrong proof of my opinion.

"Theſe ſalts have a remarkable pungency. This we have already ſeen is the natural effect of quicklime on ſalts.

"Theſe ſalts are found to be the fitteſt for making ſoap, and to incorporate ſooneſt and beſt with oils. Salts, we know, of themſelves do not readily unite with oil; but when once mixed with quicklime, they have a greater tendency to union.

"Again, I find that theſe aſhes are more eaſily fluxed than charcoal made into a paſte with the third part ſalt; which is much more than the aſhes contain. Now, it is obſerved that quicklime increaſes the fluxing power of alkaline ſalts; for the common cauſtic made of quicklime and alkaline ſalts is ſooner fuſed than the latter alone.

"From theſe reaſons, and the experiments that diſcover lime in theſe aſhes, I am led to think, that it is not generated by the proceſs, but mixed with the aſhes when they are made into a paſte. The following experiment is a convincing proof of what I have been endeavouring to make out.

"I boiled ſome peaſe-ſtraw in a ſtrong lye of pearl-aſhes burnt into a black coal, and made it into a paſte with water. Another quantity of ſtraw was boiled in a lye made of one part of quicklime and four parts of pearl ſalts, the lye being poured off turbid from the lime. This ſtraw was likewiſe burnt when dry, and made into a paſte. Theſe two ſubſtances were put in-

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to separate crucibles, and fluxed in a reverberatory furnace. The latter appeared to resemble the Marcoft and Cashub ashes more than the former, which seemed to want their pungency."

12 Potashes and Pearl-ashes obtained from neutral salts.

Though the only method of preparing the alkaline salt originally is by the combustion of vegetables, yet there are some neutral salts from which if it were possible to expel the acid, we should have it in our power to procure the finest pearl-ashes in vast quantity. These are vitriolated tartar, nitre, but especially sea-salt, on account of the inexhaustible quantities of it to be met with in the waters of the ocean. Unhappily, however, there are some objections to every one of those. The vitriolated tartar, or any other salt in which the vitriolic acid enters, cannot be decomposed without converting the acid into sulphur by charcoal-dust; in which case it is as difficult to get free of the sulphur as of the acid; and if we attempt it by frequent solutions in water, we destroy the phlogiston of the sulphur, and have only vitriolated tartar again instead of alkali. See CHEMISTRY, n° 716, &c.

With respect to nitre, though its acid may be expelled by fire, yet it is too high-priced, and too much used in other manufactures, to be thought of for this purpose. A potash manufacture from sea-salt has indeed been lately erected in England. The principle on which this was established is, that the acid of sea-salt may be extracted by means of lime; and accordingly we find that the saline efflorescence, which frequently appears on walls, consists chiefly of the marine alkali deprived of its acid. But this, though delivered on the credit of a very eminent chemist, we can affirm from our own observation to be a mistake. Of the many cases in which we have examined this efflorescence, only one was found to be alkaline; the others uniformly appeared to be true Glauber's salt composed of the vitriolic acid and fossil alkali. Neither did this appear to be formed by any decomposition of salt originally in the plaster, but to be a real generation of both acid and alkali where none of them existed before. See EFFLORESCENCE.

POTATO, in botany. See SOLANUM.

1 How potatoes were introduced into Britain.

Potatoes, it is generally thought, came originally from North America, where they were not reckoned good for food. They were first (we are told) introduced into Ireland in the year 1565, and from thence into England by a vessel wrecked on the western coast, called *North Meols*, in Lancashire, a place and soil even now famous for producing this vegetable in great perfection. It was 40 years after their introduction, however, before they were much cultivated about London; and then they were considered as rarities, without any conception of the utility that might arise from bringing them into common use. At this time they were distinguished from the Spanish by the name of *Virginia potatoes*, or *battatas*, which is the Indian name of the Spanish * sort. At a meeting of the Royal Society, March 18th, 1662-3, a letter was read from Mr Buckland, a Somerset gentleman, recommending the planting of potatoes in all parts of the kingdom to prevent famine. This was referred to a committee; and, in consequence of their report, Mr Buckland had the thanks of the society, such members as had lands were intreated to plant them, and Mr Evelyn was desired to mention the proposals at the close of his Sylva.

* See *Convolvulus*, n° 5.

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In Sweden, notwithstanding the indefatigable industry of Linnæus, the culture of potatoes was only introduced in 1764, when a royal edict was published to encourage their general cultivation. They were known there, however, at an earlier period; for in *the Memoirs of the Royal Academy of Sciences in Sweden*, 1747, M. Charles Skytse proposed to distil brandy from them, in order to save corn, which in that country is very dear. He found by experience, that an acre of land set with potatoes will yield a much greater quantity of brandy than when sown with barley.

2 Their late introduction into Sweden.

3 Their great utility.

The utility of potatoes to the common people is well known, and this utility has brought them into general use, and has extended them over every part of this kingdom. To promote this utility, and to make their cultivation more easy, a variety of experiments and inquiries have been made. Some of these we shall now lay before our readers, without repeating, however, what has been said on the same subject in the article AGRICULTURE, n° 158—167. By many people the Irish purple potato is thought to be the sweetest and best; and of these the bright and middle-sized are directed to be set whole, in February, March, and April, in a fine deep tilth, in any soil. During the frost, the first setting should be covered with litter or fern. They should be set six inches deep, and a yard distant from each other every way, in a kind of hillocks like a mole-cast; and they must be moulded every month or fortnight, as high as possible. By July or August, under each hillock there will be nearly a bushel of potatoes. The white kidney potato runs all into stringy roots in loose ground, while the pink-coloured will do extremely well in the way we have now directed; and the smallest of them, though often given to hogs, unless they be otherwise improper or unhealthy, will be very good seed.

4 Remarks and experiments on their culture.

The following experiments concerning the culture of potatoes are related in the Georgical Essays.

5 Of the Howard potato.

"By all the experiments that have been made, the Howard or large Bedfordshire potato is found to produce the largest crop. On that account they are chiefly used in feeding of cattle. In two beds, four feet wide, and 200 feet long, I planted in a common field a sufficient number of sets of this kind of potato, and managed them by a horse-hoe. The produce was 64 bushels, each bushel up-heaped, weighing about 70 lb. My cattle eat them boiled with as much eagerness as the best sorts, and came on as well with them. I have built a boiling-house, &c. on Mr Young's plan, and during this whole winter have boiled potatoes for my cattle. For the fattening ones, I mix ground oats with them; and for the milk-cows, malt-dust; and dare venture to affirm, that they are much more profitable than either turnips or cabbages. Once, when my potatoes grew low, I desisted giving them to the milking-cows. Immediately, though fed with the best hay, they fell off amazingly in their milk. I therefore began again; and in a week's time they gave better than one-third more butter. I own this accidental discovery gave me much satisfaction, as it confirmed my opinion, that potatoes boiled are an excellent winter food for cattle. Their culture is not so difficult, at least not so precarious, as either turnips or cabbages. Their value is superior, and there is no risk of their giving a disagreeable taste either to butter or

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milk. Add to this the vaſt increaſe of the Howard potato, and its equality with the beſt ſorts when uſed for cattle.

6 Of the increaſe of potatoes.

"My gardener cut a large potato into nine pieces, which he planted with dung, in a drill, in the garden. By earthing up and laying the ſhoots, he produced 575 (A) ſizeable potatoes, which weighed eight ſtone eight pound. Another of my ſervants produced, in the field, ſeven ſtone of good potatoes from the ſame number of ſets. Though this experiment cannot always be executed in its full force in an extenſive ſcale, it ought, notwithſtanding, to be imitated as nearly as circumſtances will allow. It ſhows, in the moſt diſtinguiſhing manner, the uſe of clean and careful huſbandry.

"On the 14th of April, I cut a large white potato into 17 ſets, which were planted in as many hillocks, at the diſtance of four feet. In the courſe of growing, the plants were earthed up, and on the 14th of October the crop was taken up: The produce, 10 pecks of ſizeable potatoes. At the time that this experiment was made, I had ſeveral hillocks, in which I put three and four ſets of the ſame kind of potato. But, upon the moſt careful examination, I could not obſerve that theſe hillocks produced a greater crop than the others planted with a ſingle ſet. Hence it is obvious, that the potato ſpreads its roots moſt kindly when leaſt crowded."

Whilſt ſpeaking of the increaſe of potatoes, we cannot help taking notice of a memoir by John Howard, Eſq; of Cardington, in Bedfordſhire, on a new kind of potato remarkable for its prolificacy. "In the year 1765 (ſays he) being at Clifton, near Briſtol, I was informed a perſon had brought from America a new ſort of potato, and with ſome trouble I procured half a dozen roots of it, as the greateſt part of thoſe brought over were already planted. That autumn I planted three of them, and in the following ſpring the other three, in my garden at Cardington in Bedfordſhire; ſetting them in hillocks about ſix feet aſunder. The ſtrength of the ſtems, and largeneſs of the bloſſom and apples, gave the pleaſing proſpect of great increaſe: and accordingly, when I took them up in the autumn 1766, I found they had increaſed far beyond any of the common ſort, which for ſome years I had encouraged our cottagers to cultivate. The produce from each cutting was in weight from 26 to 27 pounds and a half. I ſent for two of the Bedford gardeners, who ſerve the market, to ſee them taken up, and they were ſurpriſed at the great increaſe. I gave ſome of them to theſe gardeners, and others to almoſt all our own cottagers. The increaſe continued to appear the ſame in the ſucceeding year, viz. 1767, as in the laſt: only, as many of the ſingle potatoes had been then found to weigh four or five pounds each, I had now planted moſt of them in drills three feet aſunder, in order to procure a greater number, and a leſs ſize. Their produce was now from 22 to 30 pounds from each cutting; and the potatoes were more ſizeable for common uſe. The vegetation was not ſo luxuriant as in thoſe I before planted in hillocks; but the increaſe of theſe was, allowing the cuttings to weigh one ounce, full 400-fold. Having laſt year upwards of a waggon-load of theſe potatoes, I with pleaſure ordered it to be made publicly known, that every perſon who choſe to cultivate them were welcome to have a quantity for planting. In conſequence of this, numbers applied in our own and the adjacent counties. In my plantations, as well as thoſe of other perſons, the increaſe has been ſtill greater this year: for the ſeaſon having proved very favourable, I have had from ſome hillocks 41 pounds and a half, allowing for dirt."

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We now continue our extracts from the Georgical Eſſays.

7 On raiſing ſeedling potatoes.

"Take a bunch of the apples of any ſort of potato. Hang it up in a warm room during the winter, and in February ſeparate the ſeeds from the pulp, by waſhing the apples in water, and preſſing them with the fingers. Then dry the ſeeds upon paper. In the month of April, ſow theſe ſeeds, in drills, in a bed of earth well dug, and manured with rotten dung. When the plants are about an inch high, draw a little earth up to them with a hoe, in order to lengthen their main roots. When they are about three inches high, dig them up with a ſpade, and ſeparate them carefully from each other, in order for planting out in the following manner. Prepare a piece of freſh ground by trenching it well. Dig up the ſeedling plants as before directed; and plant them out in the ground, thus prepared, in ſuch a manner that there ſhall be 16 inches between each plant. As they advance in growth, let them receive one or two earthings up, in order to lengthen the main root, and encourage the ſhoots under ground. By this management, the potatoes will, in the courſe of one ſeaſon, arrive at the ſize of hen's eggs, and the haulm will be as vigorous as if ſets had been planted. But what proves the luxuriancy in the moſt convincing manner, is, that flowers and apples are produced.

"In Lancaſhire, where the gardeners raiſe potatoes from ſeed, they are always two, and ſometimes three, years in bringing them to full ſize. By the above method of tranſplanting, with wide diſtances, many of the potatoes nearly attain their full ſize in one ſeaſon. It is obſervable, that theſe ſeedlings produce potatoes of all the different kinds; and ſometimes new ſorts are procured. We do not find any difference whether the apple comes from one kind or another. It is not ſo when we uſe the ſet, which invariably produces the ſame kind. Potatoes, when propagated from ſets, after a number of years, are found to decreaſe in bearing; for which reaſon they ſhould be brought back every 14 years to their original. From a want of attention to this circumſtance, I have known potatoes ſo run out, that they hardly returned treble ſeed. The farmer complains that his land is tired of them; but the true cauſe

(A) Inſtances of the amazing increaſe of potatoes are very numerous, and are almoſt every year detailed in the public papers. In the Gentleman's Magazine for 1757, p. 480, we are told, that from one ſlice of a potato, ſet in the ſpring of the ſame year by Mr Simon M'Hoy, a farmer at Park near Tuam in Ireland, there proceeded no leſs than 84 ſtalks, which produced 965 potatoes.

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cauſe is the age of the ſets. The increaſe of potatoes raiſed from ſeed is aſtoniſhing. They continue in vigour for about 14 years; after which the produce gradually declines.

8 On raiſing early potatoes.

"As the culture of potatoes, and particularly of the early ſorts for the table, has of late become an object of very general attention, I hope the following account of a new method of obtaining theſe (without the help of hot-beds) will be acceptable to the public.

"On the 2d of January 1772, I made a hot-bed for the forward ſort of potatoes, and on the 7th put in the ſets, placing a glaſs and frame over them, and taking every precaution to defend them from the froſt. Of theſe ſmall potatoes, or ſets, there remained about 40 in a baſket, which was accidentally hung up in a warm kitchen, and there remained unnoticed till about the 25th of April. I then accidentally obſerved the baſket, and perceiving ſomething green on the edge of it, took it down, and, to my great ſurpriſe, found that the potatoes had ſprouted half a yard in length, and that there were a great number of very ſmall potatoes formed on the fibrous roots which had grown out. I took them into my garden, and planted them in a rich ſandy ſoil, without any manure. The roots I put into the ground three inches deep, and laid down the ſtems that had ſprouted, horizontally, and covered them with two inches of ſoil, but left the tops uncovered. Without farther attention they grew ſurpriſingly.

"On the 26th of May, I took up the roots planted in the hot-bed on the 7th of January. They by no means anſwered my expectations, or paid for the trouble of their culture: but, at the ſame time, I was aſtoniſhed to find the others, which were put into the ground ſo late, to have produced larger potatoes than the roots in the hot-bed. I took up all the roots, and picked off the large potatoes from them, which amounted to from 4 to 12 on each root, and then ſet the roots again in the ſame ground. This, indeed, I have ſucceſsfully practiſed for many years, ſometimes even twice, and have had a third good crop at Michaelmas. When this method is tried, the roots muſt be watered on the evenings of hot days.

"In January 1773, in order to make a ſecond trial of this experiment with a large quantity, I placed a great many potatoes of the early ſorts on a thick layer of gravelly ſoil, cloſe to each other, over an oven, ſlated over, but open to the ſouth-weſt, and covered them two inches deep with the ſame earth. At the end of April I took them up, and found the ſtems about a foot long or more. For fear of injuring the fine and delicate fibres of the roots, I took great care in taking them up, and planting them in the ſoil. This I now manured, but in all other reſpects treated them in the manner above deſcribed, many of the fibrous roots having then potatoes formed upon them nearly as large as walnuts. For a week, the plants came on ſurpriſingly, when, by one ſharp night's uncommon froſt, they were nearly deſtroyed. However, notwithſtanding this, freſh ſtems grew up in a few days, and I actually gathered from them, on the 3d of June following, finer potatoes than were ſold at that time, at Mancheſter, from 1 s. to 1 s. 6 d. per pound, being the produce of hot-beds. After taking off the larger potatoes, I again planted the roots for a ſecond crop, and in September obtained a very large produce. I weighed the increaſe of many ſeparate roots, which amounted from four pound eight ounces to 14 pound 12 ounces, the potatoes being the largeſt of the forward kinds I ever ſaw.

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9 On raiſing them in winter.

"Make a compoſt of earth, ſand, and coal-aſhes. With this mixture fill a tub about 16 inches deep. Plant this artificial ſoil with ſome ſets of the early round potato, and place the tub in a ſtable oppoſite to a window, taking care to water the earth now and then. In all ſeaſons the ſets will ſprout, and give a tolerable increaſe of potatoes. Laſt November I planted ſome ſets in the above manner; and in February following I took up a conſiderable number of young potatoes, clean ſkinned and well flavoured.

10 On tranſ. planting potato tops.

"On the 18th of May 1772, finding ſome beds I had ſown very early with onions, to be a miſſing crop, I was induced to make the following experiment. The year before, I had ſet ſome potatoes in another part of my garden in the common way; and as it is impoſſible but ſome will remain in the ground all winter, ſo I found a number of ſprouts about three inches high, which I nipped off cloſe to the ground, and tranſplanted them into the onion-beds, without any further preparation, about a foot and a half aſunder, in the ſame manner that cabbages and cauliflowers are planted. As the ſeaſon became immediately very dry, I was obliged to give my plants a little water for four or five ſucceſſive nights; after which they began to flouriſh, and had the appearance of a promiſing crop during all the ſummer. At the uſual time, in October, I ordered them to be taken up; and for ſize, quantity, and quality, they exceeded all I ever had in the common way. Had the ground been freſh, properly manured and prepared, and the plants put down at a proper diſtance from each other, I am of opinion that the ſucceſs would have been ſtill greater.

11 On feeding hogs, &c. with potatoes.

"From an accurate experiment made laſt year, I dare venture to recommend baked potatoes as an excellent food for hogs. The pork produced by this food was equal to that from barley and beans: but at preſent I cannot exactly aſcertain the comparative experiment with regard to expence; however, I am of opinion, that roaſted potatoes, conſidering the improvement of the hogs, is as cheap a food, if not cheaper, than can be given them. I roaſted my potatoes upon a kiln, ſimilar to what is uſed by oatmeal ſhellers for drying their oats. The difference in expence between boiling and roaſting the potatoes is prodigious, both with regard to the labour and fuel. A kiln that will coſt 3 l. will roaſt potatoes ſufficient for the maintenance of more than 20 hogs; and one man will beſtow all the neceſſary attendance upon them, and do other work beſides. The action of the fire, by diſſipating the crude juices that are contained in raw potatoes, reduces them into a ſtate highly wholeſome and nutritious. Boiling does this in part, but not ſo effectually. A potato roaſted in the manner above deſcribed, partakes much of the nature of a cheſnut, and perhaps is not greatly inferior to it."

Potatoes are found to be uſeful food for moſt other animals. See AGRICULTURE, n° 45.

To theſe experiments we ſhall add ſome important obſervations of Dr Anderſon of Cotefield near Leith,

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12 Remarks on the ſeeds moſt proper to be planted.

who has paid a very particular attention to this as well as other branches of agriculture. Our readers will find the Doctor's remarks and experiments at large in the *Bath Papers*, volume fourth. He firſt conſiders the nature of the ſeeds moſt proper to be planted; and from his experiments he thinks it appears that the produce is not materially affected, by planting for ſeed, either whole potatoes or cuttings, or large or ſmall potatoes as ſuch; for it is only incidentally that theſe things can affect the crop. In the fifth volume of the *Bath Papers*, Mr Wimpey relates an experiment, by which it would appear that there is an advantage in planting cut potatoes. His concluſion is as follows. "The meaſure of all the ground planted, ſays he, was 325 poles; the whole produce 378 buſhels. The meaſure of the ground planted with cut potatoes was 265 poles; the produce 312 buſhels. The ground planted with whole or uncut ſets was 60 poles, and the produce of the ſame 66 buſhels. Now, if 48 buſhels, the whole quantity of ſets uſed, produced 378 buſhels, then 34 buſhels, the quantity cut, ſhould produce 267 buſhels; but they produced 312, which is 45 buſhels more than the proportion. Again, if 48 buſhels produced 378 buſhels, then 14 buſhels ſhould have produced 110 buſhels; but 14 buſhels of uncut produced only 66 buſhels, which is 44 buſhels leſs than the proportion. A preference of 40 *per cent.* in favour of cut potatoes, in compariſon with whole ſets." Mr Wimpey corroborates the fact in the ſixth volume of the ſame work, and informs us, moreover, that he uſed to ſupply many of his neighbours with potatoes for planting; ſome of whom deſired to have them all ſmall, as they had found them equally productive with the larger, and ſaved much trouble in cutting. "Others (continues he) preferred the largeſt, who carried their economy much further: they, it ſeems, uſed to pare them, eat the fleſhy part, and plant the rinds only. Upon inquiry, I found it was not an unuſual practice among the cottagers; and I have been credibly informed they get as large crops and as good potatoes in that method of planting as in any other whatever. If this be a fact, it ſeems to appear that the fleſhy part of the bulb is of no uſe in ſupplying nouriſhment to the young fruit after the fibrous roots have put forth and laid hold of the ground. Perhaps an experiment of this ſort may be thought worth making." The weight of the crop, however, Dr Anderſon aſſerts (and Mr Wimpey agrees with him, ſee Bath Papers, vol. v. p. 34.), is always in ſome meaſure influenced by the weight of the ſeeds planted; but the weight of produce is not augmented in the *ſame proportion* with the weight of the ſeed planted; the ſmalleſt ſeed yielding the greateſt returns in proportion to the ſeed, but the ſmalleſt in proportion to the extent of ground. It is in no caſe profitable, however, the Doctor thinks to plant ſmall potatoes (B), or ſmall cuttings, unleſs where it is meant to increaſe as faſt as poſſible a favourite kind; in which caſe it may be ſometimes eligible to plant pieces very ſmall, as in that way the kind will be moſt quickly multiplied. We may alſo remark here, that ſuch as wiſh for a large increaſe ſhould never plant the worſt of the crop; it is, we know, extremely common, and may indeed be an immediate ſaving; but it is unqueſtionably a loſs upon the whole; and perhaps it is one cauſe of the *curl diſeaſe*, which is the ſure indication of a poor dwindling crop, and of which we ſhall ſpeak more at large immediately.

Potato.

Our author further remarks, that there ſeems to be no reaſon to ſuſpect that eyes taken from any particular part of the bulb are poſſeſſed of a degree of prolificacy greater than thoſe taken from any other part of it, independent of the ſize of the fleſhy part that adheres to the eye. It is however highly probable that a difference in the crop, either with reſpect to the number and ſize, or general weight of the whole, would reſult from planting large cuttings of equal weight, taken from the big end of large potatoes, or from the point, as many eyes would be in the laſt in compariſon of the firſt. This is therefore one of the many preparatory experiments that require to be made. It is poſſible too that even the apples may be an object of value, and may indicate a thriving crop or otherwiſe; but of this there is no certainty, as no ſpecific experiments have yet been made on this ſubject.

13 On cutting the ſtems of potatoes while growing.

With reſpect to the effects of cutting the ſtems of potatoes while growing, the Doctor ſeems to be doubtful. The ſtems of potatoes, if cut while growing, and uſed green, are found to be a wholeſome food for cattle and horſes. But though ſome farmers maintain that the produce in potatoes is not leſſened by having the ſtems cut off while they are in a ſtate of vigorous vegetation; others as poſitively inſiſt that the crop is eſſentially injured by that operation. It is proper that this point ſhould be aſcertained. Probably the crop is hurt if the ſtems are cut over before they have attained a certain point of maturity, though it is poſſible they may be afterwards cut without doing any eſſential injury to it.

14 On extracting ardent ſpirits from potatoes.

We have already mentioned that an experiment was made a good while ago in Sweden, to extract ardent ſpirits from potatoes. Other experiments have been made in this country of a later date, but with little effect. This, however, appears to have proceeded either from ignorance or a want of proper attention to the fermentation and after-diſtillation; as appears from Dr Anderſon's experiment, which ſucceeded extremely well by attending to theſe proceſſes. What he made he aſſerts to have been the fineſt and moſt agreeable vinous ſpirit he ever ſaw, reſembling in taſte very fine brandy, but more mild, and having a certain coolneſs on the ſtomach peculiar to itſelf.

Much may be done in bringing potatoes to perfection

(B) In oppoſition to this, it is the opinion of even practical men, that the ſmall potatoes are to be preferred. "I have been informed (ſays Mr Hollins) by a native of America, that what we call the long red American potato, grows in that rich and newly-cleared ſoil to a very large ſize; but that the potatoes proceeding from the roots were never uſed as ſeed; for there ſprung from the ſtalk, very near the ſurface of the ground, ſmall potatoes as they called them; but, he ſaid, they were about the ſize of thoſe raiſed in England, and thoſe were always planted. I hope the Society will forgive my mentioning this, as it confirms what I have already ſaid, 'that ſmall potatoes are beſt for ſeed." *London Society of Arts*, vol. xi. p. 82.

Potato. tion by attending to their ſeveral varieties. For this purpoſe ſome particular potato muſt be fixed upon as a ſtandard; and when this is done, the inquiry muſt be carried on by attending, *firſt*, to their appearances below ground, as, 1. the general form and ſize of the bulbs; 2. their colour; 3. the ſmoothneſs or roughneſs of the ſkin; 4. the conſiſtence, that is, the mealineſs or viſcoſity and taſte of the bulb; 5. the colour, length, thickneſs, &c. of the umbilical cord; 6. their tendency to go deep, or to riſe near the ſurface; to ramble wide, or to adhere cloſe to the ſtem; 7. the time when the bulbs knot and ſet; marking, not by the kalendar only, but alſo compared with the advance of the plant above ground; 8. the time when they attain perfect maturity with reſpect to ſize, and alſo that period of their growth at which they loſe the herbaceous, and attain the farinaceous, taſte; 9. their general prolificacy; 10. how long they may be kept, at what ſeaſon they are in greateſt perfection for eating, &c. We muſt *next* attend to the particulars obſervable above-ground; as, 1. the general height, colour, and form of the ſtem; 2. their tendency to puſh out many or few ſtems from a root; 3. whether they carry bloſſom or not; 4. the form, dimenſions, and colour of the leaves; 5. the form, colour, and general habitude of the bloſſom where there is any; 6. the time at which the bloſſom appears; 7. the tendency they have to produce few or many apples; 8. the tendency they have to produce thoſe excreſcences on the ſtalks that reſemble potatoes below ground, which may be called air potatoes; 9. the comparative hardneſs or tenderneſs of the leaves, in reſpect of froſt or other variations of weather that affect them. And, *laſtly*, we muſt attend to the particulars that concern the whole plant; as, 1. the ſoil which ſeems beſt to ſuit each kind; 2. the mode of culture that beſt agrees with them; 3. the accidents which are moſt liable to affect them; and in general every particular that could indicate any difference between one kind and another.

15 On attending to the ſeveral varieties of potatoes.

16 Opinions on raiſing ſeedling potatoes.

Our author next conſiders the circumſtances of raiſing ſeedling potatoes. His mode of raiſing them was ſimilar to that recommended in the *Georgical Eſſays* quoted above; but he differs with reſpect to the utility or ſucceſs of that mode. It has been alleged, he ſays, that potatoes, which have been long propagated by means of bulbs, loſe in time their generative quality, ſo as to become much leſs prolific than at firſt; and it is aſſerted that thoſe bulbs which have been lately obtained from ſeeds are much more prolific, and conſequently much more profitable for being employed as plants than others: but this opinion appears to have been adopted without ſufficient examination: for there appears not the ſmalleſt indication of ſuperior prolificacy in thoſe raiſed from ſeeds, but rather the reverſe. That potatoes do not degenerate in point of prolificacy in conſequence of being long propagated in the uſual way, ſeems to be confirmed by the general experience of all Europe. It is now about a hundred years ſince the potato was pretty generally cultivated in Ireland, and it has been very univerſally cultivated in Britain for 50 years paſt; and all that have been reared in it ſince their firſt introduction two hundred years ago, a very few of late only excepted, have been propagated from bulbs only; ſo that if they had declined in point of prolificacy, the degeneracy ſhould in this time have been very apparent. Nothing of that kind however was ever remarked, nor any inſinuation of that ſort thrown out, till the diſcovery of rearing potatoes from ſeed was made, when it was for the firſt time heard of. There are many perſons now living who have been in the conſtant practice of rearing potatoes for 30 or 40 years; and notwithſtanding the general tendency that mankind have to diſpraiſe the preſent, when compared to paſt times, yet none of them have given the ſmalleſt hint of degeneracy in this reſpect. And perhaps it will be found that this is merely a groundleſs notion, that has originated from the partial fondneſs of thoſe who firſt propagated this plant from ſeed, in favour of their new diſcovery. It has been further ſaid, that by raiſing potatoes from ſeed, many new and valuable kinds may be obtained; and it is alſo aſſerted in the *Georgical Eſſays*. Indeed an opinion of obtaining new varieties of plants by propagating them from ſeed univerſally prevails among naturaliſts. But Dr Anderſon, in his firſt paper, doubts whether this be fact, and whether, when any of theſe occur, they have not been the effect of accidental poſition or other cauſes. We may certainly (ſays he) aſſert on the whole, that if the practice of rearing potatoes from ſeeds ſhall ever be productive of any advantages to ſociety, they have not yet been diſcovered. Since he wrote that treatiſe which appears in the Bath Papers, vol. iv. (and of which we are now giving a ſhort account), however, he has had occaſion to alter his opinion, which he does with great candour in vol. v. The experiment which induced him to alter his opinion, and which appears to be deciſive, was made with the ſeed of a potato procured from Ireland of a very peculiar kind. Its colour was a dirty dark purple, its ſhape a round irregular bulb, and its ſtem tall and upright. The ſeeds procured from this potato were ſown by themſelves, and the ſeedlings when of a proper ſize were tranſplanted. From the appearance of the ſtems he ſoon diſcovered that they were not all of one ſort, and on taking them up the variety was almoſt infinite; and ſuch as could not be accounted for on the principles of a mongrel adulteration. The diverſities reſpected colour, ſhape, &c. ſome of which he enumerates. See *Bath Papers*, vol. v. p. 127.; ſee alſo p. 35. where Mr Wimpey controverts the Doctor's former opinion.

17 On the curled diſeaſe.

Reſpecting the cauſes and prevention of the *curled diſeaſe* in potatoes there has been a great variety of opinions, which we have detailed at ſome length under the article AGRICULTURE, p. 267 to 270. Dr Anderſon confeſſes that he can ſay but little *poſitive* as to the cauſe of this diſorder, but he thinks a good deal may be ſaid on the *negative* ſide of the queſtion. It was little known till lately (c), and in the northern parts of this iſland it was abſolutely unknown but a very few years ago; and even now in the more remote corners it is ſtill leſs frequent than in the more ſouthern and

(c) In the eighth volume of the Tranſactions of the London Society for Encouragement of Arts, &c. p. 43. we are told that the curl firſt appeared in 1764, in the very diſtrict in Lancaſhire where they were firſt cultivated.

Potato. and more commercial diſtricts of the iſland. It has been ſuppoſed that nature, fated as it were by having long produced this plant in a climate not deemed congenial to it, had become ſo far exhauſted as to occaſion this diſeaſe. But in this caſe, the more northern parts, where the climate is moſt unfavourable, ſhould have been ſooneſt affected. It has been alſo thought that potatoes, whoſe bulbs are froſt-bitten before they are houſed, occaſion this diſeaſe in the plants they produce. But the fact is, that they are leaſt liable to the diſeaſe in thoſe diſtricts where they are moſt expoſed to froſt. A potato can never indeed be benefited by froſt; but it is not at all probable that the being touched by it occaſions the curl. The taking up potatoes before they arrive at maturity has been thought to occaſion the diſeaſe; but in places where they muſt be taken up ſo, the diſeaſe is ſcarcely known. It has alſo been thought that potatoes obtained from *ſeed* are entirely free from it. But Dr Anderſon gives a proof of the contrary; for one half of the plants of a large field planted from potatoes the third year from the ſeed were curled; while another field adjoining raiſed from potatoes that never were, that he knows, produced from ſeed in this country, had ſcarcely one curled plant in the whole. The diſeaſe has been ſuppoſed by others to ariſe from the ſoil or ſeaſon. But that this is not the caſe, appears from the circumſtance of a ſingle field which Dr Anderſon planted with potatoes of the very ſame ſort, but obtained from different perſons. The ridges were intermixed, and the one was very much curled, and the other perfectly free. The diſeaſe, therefore, appears to ariſe from infected ſeed: it is however poſſible that it may be communicated by juxtapoſition; and if ſo, the diſeaſe might be in a great meaſure if not entirely avoided, by pulling out thoſe that ſhowed the leaſt ſymptom of it, on their firſt appearing above ground.

In the Tranſactions of the London Society for encouragement of arts, &c. we find a good deal about the curl diſeaſe. Many of the writers agree in opinion with Dr Anderſon in many particulars; and particularly, that though the diſeaſe may be prevented, we do not yet know enough of its nature to be able to cure it. See their vol. viii. p. 18, &c. ix. p. 52, &c. and x. p. 75. In this laſt volume we are told that the principal cauſes of the curl are three: 1. From their being forced by cultivation to overgrow their power for vegetation; 2. From their vegetative power being dried up in ebb ſoil by the ſcorching heat of the ſun; and, 3. From their being expoſed too long after they are cut in ſets before they are planted.

18 On the ſoil and ſeaſon moſt proper for potatoes.

It is generally and very naturally believed that a dry ſoil or a dry ſeaſon neceſſarily produces the drieſt potatoes. But there is good reaſon to doubt the truth of the opinion. The year 1775 was the drieſt and warmeſt ſeaſon that has been known in Scotland within the memory of man, yet the potatoes of that year's crop were watery almoſt to a proverb: on the other hand, the potatoes of crop 1777, although it was a remarkably rainy ſeaſon, were as dry and meally at leaſt as is common, and much more ſo than in the year 1775. It deſerves alſo to be remarked, that the crop of 1775 was almoſt double in quantity to that of 1777. Hence a dry ſeaſon would ſeem to augment the produce, though it does not for certain in all caſes improve the quality, of this crop: nor does a dry ſoil neceſſarily inſure meally potatoes; for our author ſays he has often ſeen potatoes of the ſame kind, and of the ſame year's produce, reared in two different places; the one of them in a naturally damp ſoil, which turned out to be much freer and more meally than the others which were reared on a drier and ſharper ſoil. He confeſſes, that he has alſo often ſeen it turn out in fact, that potatoes raiſed in thoſe diſtricts where the ſoil is hot and ſandy, are uſually more free and tender than thoſe raiſed in countries where the ſoil is cold and damp. Our author tries to account for theſe contradictory phenomena by conjecturing the probable cauſe of the wateryneſs or dryneſs of a crop. He aſks, Whether in this reſpect the crop is anywiſe affected by the degree of ripeneſs that the plants employed for ſeed may have attained in the preceding ſeaſon? That this is the caſe he thinks highly probable. Potatoes which, on account of the richneſs or other peculiarity of the ſoil, continue in a ſtate of vegetation highly luxuriant till they are nipped by froſt, or checked in their growth by other inclemencies of the ſeaſon, have much leſs chance of being dry and meally than others of the ſame ſort which have attained their full growth before the coldneſs or inclemency of the weather checked them. But our author's queſtion does not relate to this, but to the effect theſe unripe potatoes, uſed as ſeed, would have on the ſucceeding crop; a circumſtance which experience alone can determine. "But even if it ſhould be found (continues our author) that the maturity of the ſeeds affected the quality of the potatoes, it would not follow invariably that the ſeeds produced on early dry ſoils would be better than thoſe from later ſoils; becauſe it might ſometimes happen from local poſition, and other accidental circumſtances, that the growth of the potatoes in the dry early ſoil might be checked by froſts many weeks before thoſe on the other ſoil were affected, in conſequence of which the plants in the cold ſoil might attain to more perfect maturity than thoſe on the drier one. I mention this peculiarity merely to ſhow how cautious the farmer ought to be in adopting general concluſions without carefully attending to all the collateral circumſtances that may affect his experiment. I ſhall only farther add on this head, that I had occaſion to know well a dry warm ſpot of ground on which the ſtems of the potatoes of crop 1776 were froſt-bitten at leaſt *ſix weeks* before thoſe on another ſpot at ſome miles diſtance from it, where the ſoil was naturally more cold and damp, were in the ſmalleſt degree affected by it. It likewiſe ſo happened, that the potatoes raiſed on the firſt-mentioned ſpot in the year 1777 (their own froſt-bitten (D) ſeed was employed) had ſuch a peculiar acrid and bitteriſh taſte as to be hardly at all eatable, while thoſe in the colder place of that crop had nothing of that unuſual

(D) Obſerve, the term *froſt-bitten* is here applied to the ſtems only, and not to the bulbs. The ſtems were ſo much hurt by the froſt as to turn black and decay, but the bulbs were taken up before the froſt had been ſufficiently intenſe to hurt them.

Potato. usual taste. Whether this diversity was occasioned by the circumstance here alluded to, I do not take it on me to say. In matters of such nice disquisition as the present, many facts obtained by very accurate observation are necessary before any conclusion can be relied on."

Potatoes, when planted in water, shoot out a great number of fine white roots like threads into the water; but on none of them is there to be found the least appearance of a bulb; while on the other hand the potatoes in that case always grow on the top. Potatoes are found to be extremely useful in bringing exhausted land into heart again. See AGRICULTURE, n° 35 and 186, p. 309, col. 1. The bishop of Killalue in Ireland directs the use of them for this purpose in a letter in the *Bath Papers*, vol. 4. p. 232, and confirms its utility in this respect by experiments of his own. In the 10th vol. of the *Transactions of the London Society for Encouragement of Arts*, &c. p. 34, there is also a most decisive proof of this utility.

We have been induced, from the extensive utility of this root, to extend our observations on the subject to a greater length than we should otherwise have done. Such of our readers as wish for further information, will of course consult the books from which we have made up the present article, as well as other books on Agriculture; in which they will find the observations and experiments which we have mentioned at muchgreater length than we could possibly give them. In the sixth volume of the *Bath Society Papers* there is an excellent paper on the culture of potatoes and feeding hogs with them during seven years by John Billingsley Esq; of which our limits do not permit us to take particular notice. There are also a variety of other papers in the several volumes of that work, as well as in the Transactions of the London Society, which we have already several times mentioned; which will deserve the particular attention of such as wish well to the poor, or have a desire still farther to extend the utility of this most valuable root. We have already mentioned a cheap preparation by means of potatoes for the poor, see AGRICULTURE, n° 161; and we shall finish the present article with a receipt to make a potato herrico, which may be equally useful to those whose circumstances are not such as to make them regardless of economy. We take it from the Gentleman's Magazine, and give it in the words of a person who had tried the experiment.

Scrape the skin clean off four pounds of good raw potatoes, then wash them clean in fair water: take two pounds of beef, one of mutton, and one of pork; or as you like best, four pounds of any of these meats; cut them into pieces of three or four ounces each, season them very well with pepper and salt and a good onion chopped very small: have ready a strong wide-mouthed stone-jar, such as hares are usually jugged in; slice thin a layer of the potatoes into the jar, then a layer of the seasoned meat over them, and so alternately layers of potatoes and meat; let your uppermost layer be potatoes, so that your jar be about three quarters full, but put no water into your jar; then close or stop the mouth of it with a large well-fitted piece of cork, covering the same with a strong piece of canvas, and tyeing it down with pack-thread, so as only a little of the steam may escape in the stewing; for a little should constantly evaporate from the side of the cork to save the jar from bursting. Then place your jar upright in a kettle of cold water on the fire, so as the mouth of the jar may be always two inches above the water in the kettle when boiling. The herrico in the jar will begin to boil some minutes sooner than the water in the kettle, and that for obvious reasons. In about an hour after the water in the kettle begins to boil, your herrico will be fully stewed. Then take out and open the jar, pour out the herrico into a deep dish, and serve it up. Potato ‖ Potentilla.

This excellent, wholesome, and economical dish supplies an agreeable dinner twice a week to a family consisting of three grown people, and three children under fourteen years of age, where neither health nor good stomachs are wanting, thanks to God: and, in point of economy we must observe, that here is the whole article of butter saved, as also the whole article of bread, or nearly so; nor does there require so large or so continued a fire, nor so much time or trouble as is necessary for the dressing of many other dishes that by no means deserve the preference to this excellent herrico.

We have also (by way of change) made it with powdered beef, sometimes with powdered pork, sometimes with half fresh beef or mutton and half pickled pork, and found it good in all these ways, particularly with three pounds of fresh beef and one of pickled pork. We have left off sending pies and stews to the bakers. We sometimes (in a larger kettle) boil a small piece of powdered beef along-side of the jar, by continuing the boiling an hour and an half longer, and this serves us to eat cold the next day, with hot garden-stuff or a pudding.

POTATO-Bread. See *BREAD of Potatoes*.

Spanish POTATO. See CONVOLVULUS, n° 5.

POTENT, or POTENCE, in heraldry, a term for a kind of cross, whose ends all terminate like the head of a crutch. It is otherwise called the *Jerusalem cross*, and is represented Plate CCXXIX, fig. 12, 12.

POTENTIA (POWER), that whereby a thing is capable either of acting or being acted upon.

POTENTIAL, in the schools, is used to denote and distinguish a kind of qualities, which are supposed to exist in the body *in potentia* only; by which they are capable in some measure of affecting and impressing on us the ideas of such qualities, though not actually inherent in themselves; in which sense we say, potential heat, potential cold, &c.

POTENTIAL Cautery, in medicine, denotes the consuming, or reducing to an eschar, any part of the human body by a caustic alkaline or metallic salt, &c. instead of a red-hot iron, which last is called the *actual cautery*.

POTENTIAL, in grammar, an epithet applied to one of the moods of verbs. The potential is the same in form with the subjunctive, and is, according to Ruddiman, implied in that mood, for which reason that grammarian rejects it; but others will have it to differ from the subjunctive in this, that it always implies in it either *possum*, *volo*, or *debeo*. It is sometimes called the *permissive mood*, because it often implies a permission or concession to do a thing. See GRAMMAR.

POTENTILLA, SILVER-WEED, *wild tansey*, or *cinquefoil*: A genus of the pentagynia order, belonging to the icosandria class of plants; and in the natural method ranking under the 35th order, *Senticosæ*. The calyx is decemfid; there are five petals; the seeds roundish, naked, and affixed to a small dry receptacle. The species are, 1. The fruticosa, or shrubby potentilla, com-

Potentilla, Poterium.

monly called *ſhrub-cinquefoil*. This riſes with a ſhort ſhrubby ſtem, dividing into a branchy full head, three or four feet high; cloſely garniſhed with pinnated leaves of five oblong, narrow, acute-pointed, folioles, pale green above, and whitiſh underneath; and the branches terminated by cluſters of large, ſpreading, yellow flowers. This is a beautiful deciduous flowering ſhrub, worthy a place in every curious collection. It grows wild in Yorkſhire and other northern parts of England, &c. but has been long cultivated in gardens as an ornamental ſhrub. 2. The reptans, or creeping common five-leaved potentilla, or five-leaved graſs, hath a thick fibry root, ſlender, trailing, repent ſtalks, digitated, five-lobed, petiolated leaves, and yellow flowers ſingly. 3. The rupeſtris, or mountain upright cinquefoil, hath upright ſtalks, eight or nine inches high; pinnated five and three-lobed alternate leaves, having oval crenated lobes, and the ſtalks terminated by ſmall white flowers. 4. The recta, or erect ſeven-lobed yellow cinquefoil, hath erect ſtalks, ſeven-lobed leaves; having three lobes ſpear-ſhaped and ſerrated, green and hairy on both ſides, and the ſtalks terminated by corymboſe cluſters of yellow flowers. 5. The fragaroides, or ſtrawberry-like trailing potentilla, hath a ſomewhat tuberous root, furniſhed with many long fibres, long trailing ſhoots, rooting at the joints; pinnated, moſtly three-lobed leaves, having oval lobes, with the extreme lobe the largeſt, and cluſters of ſmall white flowers. This ſpecies bears a great reſemblance to the ſmall ſterile ſtrawberry plants. 6. The argentea, ſilvery upright potentilla, hath upright ſtalks, branching a foot high; and five-lobed leaves, having the lobes wedge-ſhaped, cut on the edges, hoary and white underneath, and the branches terminated by ſmall yellow flowers.

All theſe plants flower in June and July; the flowers are compoſed each of five roundiſh petals, and about 20 ſtamina. They are all very hardy, and may be employed in the different compartments of the pleaſure ground. Their propagation is very eaſy. The ſhrubby potentilla may be propagated abundantly by ſuckers, layers, and cuttings; all of which will readily grow, and make plants in one year, which after having two or three years growth in the nurſery will be fit for any of the ſhrubbery compartments. All the herbaceous kinds may be propagated by parting the roots in autumn or ſpring, or by ſeed in any of thoſe ſeaſons.

POTERIUM, GARDEN BURNET: A genus of the polyandria order, belonging to the monœcia claſs of plants; and in the natural method ranking under the 54th order, *Miſcellaneæ*. The male calyx is tetraphyllous; the corolla quadripartite; and there are from 30 to 40 ſtamina. The female calyx is tetraphyllous; the corolla quadripartite; there are two piſtils; the berry is formed of the indurated tube of the corolla. The ſpecies are, 1. The ſanguiſorba, or common garden burnet, hath fibry perennial roots, crowned by a large tuft of pinnated leaves, or ſix or ſeven pair of ſawed lobes, terminated by an odd one; upright angular ſtalks, dividing, and branching a foot and a half high, terminated by oblong ſpikes of purpliſh red flowers. This ſpecies grows wild in England, in chalky ſoils; but has been long cultivated as a choice ſalad-herb for winter and ſpring uſe, it being of a warm nature; the young leaves are the uſeful parts. It is perennial in root, and retains its radical leaves all the year, but the ſtalks are annual. 2. The hybridum, hybrid agrimony-leaved Montpelier burnet, riſes with upright, taper, cloſely gathered ſtalks two feet high; pinnated odoriferous leaves of three or four pair of ſawed lobes, terminated by an odd one; and the ſtalks terminated by long foot-ſtalks dividing into ſmaller, each ſupporting a ſmall roundiſh ſpike of flowers. This ſpecies often proves biennial; but by cutting down ſome of the ſtalks before they flower, it will cauſe it to multiply at bottom, and become abiding. 3. Poterium ſpinoſum, ſhrubby ſpinous burnet of Crete, hath a ſhrubby ſtem and branches, riſing a yard high, armed with ſpines; ſmall pinnated evergreen leaves, of ſix or ſeven pair of lobes, terminated by an odd one, and the branches terminated by ſmall heads of greeniſh flowers.

Poterium ‖ Poteſi.

All theſe ſpecies flower in June and July, ſucceeded by ripe ſeeds in Autumn. They are all naturally perennial; but the two herbaceous ones are abiding in root only; the other in root, ſtem, and branches: the two former are hardy, and the third requires ſhelter in winter. The firſt ſort merits culture in every kitchen-garden for winter and ſpring ſalads. Some plants, both of the firſt and ſecond ſorts, may be introduced in the herbaceous collection in the pleaſure-garden for variety. The third ſort muſt be kept always in pots to have ſhelter in winter. They are all eaſily propagated, the firſt ſort by ſeed and by parting the roots. The ſecond ſort may alſo be increaſed by ſeeds and ſlips off the root, as for the former ſort. And the propagation of the third is by ſlips or cuttings of the branches in ſpring and ſummer, planted in pots, and placed under glaſſes, giving ſhade and water; or might be forwarded more by plunging them in a hot-bed.

Burnet is of a heating, drying nature, cordial and alexipharmac; in ſummer, the leaves are uſed for cool tankards, to give the wine an agreeable flavour. The powder of the root of the firſt ſpecies is commended againſt ſpitting of blood, bleeding at the noſe, dyſenteries, and diſeaſes attended with violent ſecretions. In winter and ſpring, the young tender leaves are uſed in ſalads. For its uſes as food for cattle, ſee AGRICULTURE, n° 184.

POTHOS, in botany; a genus of the polyandria order, belonging to the gynandria claſs of plants. The ſpatha or ſheath is a ſimple ſpadix covered; there is no calyx, but four petals, and as many ſtamina; the berries diſpermous.

POTION, a liquid medicine, conſiſting of as much as can be drunk at one draught.

POTIPHAR, or PUTIPHAR, an officer of the court of Pharaoh king of Egypt, and general of his troops, according to our tranſlation, Le Clerc, and the verſion of the vulgate; but according to the Hebrew and Septuagint, the chief of his butchers or cooks. The Hebrew text, the Septuagint, and vulgate, call him Eunuch. But it is probable it in this place means only an officer of the king's court, for he was certainly married and had children. We have no other accounts of him but what appear in ſcripture; and that account is too generally known to require to be enlarged on in this place. See Geneſis xxxviii. xxxix. &c.

POTOSI, a city of Peru in South America, ſituated at the bottom of a mountain of that name, in which is the richeſt ſilver mine ever diſcovered. To give an idea of its richneſs, we ſhall mention its produce at different

Potſdam, Pott.

ferent times. Excluſive of what was not regiſtered, ſays Abbé Raynal, and was ſmuggled away, the fifth part belonging to the government, from 1545 to 1564, amounted to 36,450,000 livres * *per annum*. But this abundance of metals ſoon decreaſed. From 1564 to 1585, the annual fifth part amounted to no more than 15,187,489 livres four ſols §. From 1585 to 1624, it amounted to 12,149,994 livres 12 ſols †. From 1624 to 1633, to 6,074,997 livres ſix ſols ‡. From this laſt period, the produce of theſe mines hath ſo evidently decreaſed, that in 1763 the fifth part, belonging to the king, did not exceed 1,364,682 livres 12 ſols ‖. Situated in W. Long. 67. S. Lat. 22. See the article PERU, p. 220, col. 2.

* 151,875 l.

§ 632,812 l. 1 s.

† 506,249 l. 15 s. 6 d.

‡ 253,124 l. 17 s. 9 d.

‖ 56,861 l. 15 s. 9 d.

POTSDAM, or POSTDAM, a town of Germany, in the circle of Upper Saxony, with a palace, belonging to the king of Pruſſia. It is ſeated in an iſland ten miles in circumference, formed by the rivers Sprae and Havel. The palace is very curious, and finely built upon a delightful ſpot 12 miles weſt of Berlin. E. Long. 13. 42. N. Lat. 52. 34. Reiſbeck in his travels informs us, that the houſes in Potſdam are ſtill finer than thoſe of Berlin; but like them they are inhabited only by perſons of the lower and middling ranks.

POTT (Percival), was born in London in 1713. He received the firſt rudiments of his education at a private ſchool at Darne in Kent; and became an apprentice to Mr Nourſe, one of the ſurgeons of St Bartholomew's hoſpital; of which hoſpital, in 1744-5, he was elected an aſſiſtant ſurgeon, and in 1749 appointed one of the principal ſurgeons. In 1746, he married the daughter of Robert Cruttenden, Eſq. His firſt publication is ſaid to have been planned in 1756, during his confinement in conſequence of a compound fracture of the leg: from that time, his pen was ſeldom long unemployed. His practice and his reputation were now rapidly increaſing: in 1764, he was elected a fellow of the Royal Society; and afterward was complimented with honorary diplomas from the Royal Colleges of Surgeons at Edinburgh and in Ireland. In 1787, he reſigned the office of ſurgeon to St Bartholomew's hoſpital, "after having ſerved it (as he uſed to ſay), man and boy, half a century;" and on the 22d of December 1788, after an illneſs of eight days, he expired.

"The labours of the greateſt part of his life (ſays Mr Earle, who publiſhed his Chirurgical works), were without relaxation; an increaſing family required his utmoſt exertion: of late years he had a villa at Neaſden; and in the autumn uſually paſſed a month at Bath, or at the ſea-ſide. Thus, though he gathered, as he expreſſed it, ſome of the fruit of the garden which he had planted as he went along, and always lived in a generous and hoſpitable manner, at the ſame time beſtowing on four ſons and four daughters a liberal and neceſſarily expenſive education, and applying large ſums to their eſtabliſhment during his lifetime, he left an ample proviſion for them at his deceaſe. Among his papers was found, what he had often mentioned, a ſmall box, containing a few pieces of money, being the whole which he ever received from the wreck of his father's fortune. With this was depoſited an exact account of every individual fee which a long life of buſineſs had produced—abundant evidence of well ſpent time, and the induſtrious application of abilities, to which the *res anguſta domi*, at the commencement, probably acted more powerfully as an incentive than as an obſtacle."

Potter, Pottery.

POTTER (Chriſtopher), a learned Engliſh divine, was born in 1591, and bred at Oxford. In 1633, he publiſhed his "Anſwer to a late Popiſh Plot," intitled *Charity miſtaken*, which he wrote by ſpecial order of King Charles I. whoſe chaplain he was. In 1634, he was promoted to the deanery of Worceſter; and, in 1640, was conſtituted vice-chancellor of the univerſity of Oxford, in the execution of which office he met with ſome trouble from the members of the long parliament. Upon breaking out of the civil wars, he ſent all his plate to the king, declaring, "that he would rather, like Diogenes, drink in the hollow of his hand, than that his majeſty ſhould want;" and he afterwards ſuffered much for the royal cauſe. In conſideration of this he was nominated to the deanery of Durham in 1646, but was prevented from being inſtalled by his death, which happened about two months after. He was a perſon learned and religious, exemplary in his converſation, courteous in his carriage, of a ſweet and obliging nature, and of a comely preſence. He was remarkable in his charity to the poor.

POTTER (Dr John), archbiſhop of Canterbury, was the ſon of a linen-draper at Wakefield in Yorkſhire, where he was born about the year 1674. He ſtudied at Univerſity college, Oxford; and at 19 publiſhed *Variantes lectiones & notæ ad Plutarchi librum de audiendis poetis; & ad Baſilii magni orationem ad juvenes, quomodo cum fructu legere poſſint Græcorum libros*, 8vo, 1693. In 1697, came out his edition of *Lycophron*, in folio; which is reckoned the beſt of that obſcure writer: ſoon after, he publiſhed his *Antiquities of Greece*, 2 vols 8vo. Theſe works eſtabliſhed his literary reputation, and engaged him in a correſpondence with Grævius and other learned foreigners. In 1706, he was made chaplain to the queen; in 1715, biſhop of Oxford; and in 1737, he ſucceeded archbiſhop Wake in the ſee of Canterbury; which high ſtation he ſupported with much dignity until his death in 1747. He was a learned and exemplary churchman; but not of an amiable diſpoſition, being but too ſtrongly tinctured with the pride of office; nor is it to his credit that he diſinherited his eldeſt ſon for marrying below his rank in life. His "Theological works, containing ſermons, charges, diſcourſes on church-government, and divinity lectures," were printed at Oxford, in 3 vols, 8vo, 1753.

POTTERY, the manufacture of earthen-ware, or the art of making earthen veſſels. See *DELFT-Ware*, *STONE-Ware*, and PORCELAIN, &c.

The wheel and lathe are the chief and almoſt the only inſtruments in pottery: the firſt for large works, and the laſt for ſmall. The potter's wheel conſiſts principally in the nut, which is a beam or axis, whoſe foot or pivot plays perpendicularly on a free-ſtone ſole or bottom. From the four corners of this beam, which does not exceed two feet in height, ariſe four iron bars, called the *ſpokes of the wheel*; which forming diagonal lines with the beam, deſcend, and are faſtened at bottom to the edges of a ſtrong wooden circle, four feet in diameter, perfectly like the felloes of a coach-wheel, except that it has neither axis nor radii, and is only joined to the beam, which ſerves it as an axis by the iron-bars. The top of the nut is flat, of a circular

Pottery || Poverty.

cular figure, and a foot in diameter: and on this is laid the clay which is to be turned and faſhioned. The wheel thus diſpoſed is encompaſſed with four ſides of four different pieces of wood faſtened on a wooden frame; the hind-piece, which is that on which the workman ſits, is made a little inclining towards the wheel; on the fore-piece are placed the prepared earth; on the ſide-pieces he reſts his feet, and theſe are made inclining to give him more or leſs room. Having prepared the earth, the potter lays a round piece of it on the circular head of the nut, and ſitting down turns the wheel with his feet till it has got the proper velocity; then, wetting his hands with water, he preſſes his fiſt or his fingers-ends into the middle of the lump, and thus forms the cavity of the veſſel, continuing to widen it from the middle; and thus turning the inſide into form with one hand, while he proportions the outſide with the other, the wheel conſtantly turning all the while, and he wetting his hands from time to time. When the veſſel is too thick, he uſes a flat piece of iron, ſomewhat ſharp on the edge, to pare off what is redundant; and when it is finiſhed, it is taken off from the circular head by a wire paſſed under the veſſel.

The potter's lathe is alſo a kind of wheel, but more ſimple and ſlight than the former: its three chief members are an iron beam or axis three feet and a half high, and two feet and a half diameter, placed horizontally at the top of the beam, and ſerving to form the veſſel upon: and another larger wooden wheel, all of a piece, three inches thick, and two or three feet broad, faſtened to the ſame beam at the bottom, and parallel to the horizon. The beam or axis turns by a pivot at the bottom in an iron ſtand. The workman gives the motion to the lathe with his feet, by puſhing the great wheel alternately with each foot, ſtill giving it a greater or leſſer degree of motion as his work requires. They work with the lathe with the ſame inſtruments, and after the ſame manner, as with the wheel. The mouldings are formed by holding a piece of wood or iron cut in the form of the moulding to the veſſel, while the wheel is turning round; but the feet and handles are made by themſelves and ſet on with the hand; and if there be any ſculpture in the work, it is uſually done in wooden moulds, and ſtuck on piece by piece on the outſide of the veſſel. For the glazing of the work, ſee GLAZING.

POTTLE, an Engliſh meaſure containing two quarts.

POVERTY ſignifies indigence or want of riches, and has been the lot of a large portion of men in every age. Whether, on the whole, it has been productive of good or bad conſequences, has been diſputed. In a moral view, perhaps it has been, on the whole, uſeful, as adverſity is in general more conducive to virtue than proſperity, which too often leads to luxury and vice.—Sometimes, however, poverty has had a baneful effect upon the mind, and has prompted men to commit very inhuman actions; but this in civilized communities very ſeldom occurs. In a political view, poverty is thought by ſome to be hurtful: Raynal thinks it is a check to population, (ſee his Hiſtory, vol. vi. p. 471.); and Dr Smith ſo far agrees with him; for though he aſſerts, and indeed proves, that poverty is no check to the production of children, he allows it to be very unfavourable to raiſing them. See *Smith's Wealth of Nations*, vol. i. p. 119, &c. See alſo POOR.

Pouladuff || Poultry.

POULADUFF, two remarkable great holes in the ground, about a mile weſt of Roſs, in the county of Cork, and province of Munſter, in Ireland, 80 yards deep, in which the ſea flows by ſubterraneous paſſages. They are called Eaſt and Weſt *Pouladuff*; one is on the lands of Downeen, and the other on Tralong.

POULTICE, a ſort of medicine, called alſo a *cataplaſm*. See CATAPLASMA.

POULTRY, all kind of domeſtic birds brought up in yards, as cocks, hens, capons, ducks, turkeys, &c.

Almoſt, if not all the domeſtic birds of the poultry kind that we maintain in our yards are of foreign extraction: but there are others to be ranked in this claſs that are as yet in a ſtate of nature, and perhaps only wait till they become ſufficiently ſcarce to be taken under the care of man to multiply their propagation. It will appear remarkable enough, if we conſider how much the tame poultry which we have imported from diſtant climates has increaſed, and how much thoſe wild birds of the poultry kind that have never yet been taken into keeping have been diminiſhed and deſtroyed. They are all thinned; and many of the ſpecies, eſpecially in the more cultivated and populous parts of the kingdom, are utterly unſeen.

Under birds of the poultry kind may be ranked all thoſe that have white fleſh, and, comparatively to their heads and limbs, have bulky bodies. They are furniſhed with ſhort ſtrong bills for picking up grain, which is their chief and often their only ſuſtenance. Their wings are ſhort and concave; for which reaſon they are not able to fly far. They lay a great many eggs; and as they lead their young abroad, the very day they are hatched, in queſt of food, which they are ſhown by the mother, and which they pick up for themſelves, they generally make their neſts on the ground. The toes of all theſe are united by a membrane as far as the firſt articulation, and are then divided.

Under this claſs we may therefore render the common cock, the peacock, the turkey, the pintada or Guinea hen, the pheaſant, the buſtard, the grous, the partridge, and the quail. They all bear a ſtrong ſimilitude to each other, being equally granivorous, fleſhy, and delicate to the palate. They are among birds what beaſts of paſture are among quadrupeds, peaceable tenants of the field, and ſhunning the thicker parts of the foreſt, that abound with numerous animals who carry on unceaſing hoſtilities againſt them.

As nature has formed the rapacious claſs for war, ſo ſhe ſeems equally to have fitted theſe for peace, reſt, and ſociety. Their wings are but ſhort, ſo that they are ill formed for wandering from one region to another: their bills are alſo ſhort, and incapable of annoying their oppoſers: their legs are ſtrong indeed; but their toes are made for ſcratching up their food, and not for holding or tearing it. Theſe are ſufficient indications of their harmleſs nature; while their bodies, which are fat and fleſhy, render them unwieldy travellers, and incapable of ſtraying far from each other.

Accordingly, we find them chiefly in ſociety: they live together: and though they may have their diſputes, like all other animals, upon ſome occaſions; yet, when kept in the ſame diſtrict, or fed in the

ſame

Pounce ‖ Pouſſin.

ſame yard, they learn the arts of ſubordination; and, in proportion as each knows his ſtrength, he ſeldom tries a ſecond time the combat where he has once been worſted.

In this manner, all of this kind ſeem to lead an indolent voluptuous life. As they are furniſhed internally with a very ſtrong ſtomach, commonly called a *gizzard*, ſo their voraciouſneſs ſcarce knows any bounds. If kept in cloſe captivity, and ſeparated from all their former companions, they have ſtill the pleaſure of eating left; and they ſoon grow fat and unwieldy in their priſon. To ſay this more ſimply, many of the wilder ſpecies of birds, when cooped or caged, pine away, grow gloomy, and ſome refuſe all ſuſtenance whatever; none except thoſe of the poultry kind grow fat, who ſeem to loſe all remembrance of their former liberty, ſatisfied with indolence and plenty.

POUNCE, gum ſandarach pounded and ſifted very fine, to rub on paper, in order to preſerve it from ſinking, and to make it more fit to write upon.

POUNCE, is alſo a little heap of charcoal duſt, incloſed in a piece of muſlin or ſome other open ſtuff, to be paſſed over holes pricked in a work, in order to mark the lines or deſigns thereof on paper, ſilk, &c. placed underneath; which are to be afterwards finiſhed with a pen and ink, a needle, or the like. This kind of pounce is much uſed by embroiderers, to transfer their patterns upon ſtuffs; by lace-makers, and ſometimes alſo by engravers.

POUNCES, in falconry, the talons or claws of a bird of prey.

POUND, a ſtandard-weight; for the proportion and ſubdiviſions of which, ſee the article WEIGHT.

POUND alſo denotes a money of account; ſo called, becauſe the ancient pound of ſilver weighed a pound troy.

POUND, among lawyers, denotes a place of ſtrength, in which to keep cattle that are diſtrained, or put in for treſpaſs, until they are replevied or redeemed.

POUNDAGE, a ſubſidy of 12 d. in the pound, granted to the crown on all goods and merchandizes exported or imported; and if by aliens, one penny more.

POURPRESTURE, in law, is a wrongful incloſure, or incroachment upon another perſon's property.

POURSUIVANT, or PURSUIVANT, in heraldry, the loweſt order of officers at arms.—They are properly attendants on the heralds when they marſhal public ceremonies. Of theſe in England there were formerly many; but at preſent there are only four, viz. blue-mantle, rouge-croſs, rouge-dragon, and port-cullice. In Scotland there is only one king at arms, who is ſtyled *Lyon*; and has under him no leſs than ſix heralds, as many purſuivants, and a great many meſſengers at arms. See LYON.

POURVEYANCE, or PURVEYANCE, in law, the providing corn, fuel, victuals, &c. for the king's houſehold; and hence the officer who did ſo was termed *pourveyor*. As ſeveral offences were committed by theſe officers, it was enacted by ſtat. 12. Car. II. that no perſon, under colour of pourveyance, ſhall take any timber, cattle, corn, &c. from any ſubject without his free conſent, or without a juſt appraiſement and paying for the ſame.

POUSSIN (Nicholas), an eminent French painter, born in 1594, at Andel, a little city in Normandy, where his father was of noble extraction, but born to a ſmall eſtate. He was inſtructed for a few months by one Ferdinand Elle, a portrait-painter, and afterwards ſpent a month with L'Allemant; but finding theſe artiſts not likely to improve him ſuitably to his deſires, he firſt ſtudied the paintings of the beſt maſters, and then haſtened to finiſh a few pieces he was engaged in, and travelled to Italy. Here he devoted almoſt his whole attention to the ſtudy of antique ſtatues and bas reliefs; which was probably the cauſe of his want of knowledge in, and taſte for, the art of colouring. Being invited back to Paris by Louis XIII. who aſſigned him a penſion with lodgings in the Thuilleries, he painted for prince Juſtiniani an hiſtorical picture repreſenting Herod's cruelty; an admirable compoſition, in which he gave ſuch expreſſion to every character, as could not fail to ſtrike the beholder with terror and pity: he then laboured for ſeveral years on the celebrated pictures of the ſeven ſacraments of the Romiſh church. But none of Pouſſin's deſigns have been more generally admired than that of the death of Germanicus; which would have gained him immortal honour if he had never painted another picture. He began the labours of Hercules in the gallery of the Louvre; but the faction of Vouet's ſchool railing at him and his performances, put him ſo out of humour with his own country, that he returned to Rome, where he died in 1665. He never went beyond eaſel-pieces, for which he had a perpetual demand; and his method was to fix the price he expected on the back of the canvas, which was readily paid.

Pouſſin, Powder.

POUSSIN (Gaſpar). This painter, whoſe real name was *Dughet*, was born at Paris in 1600; and was induced to travel to Rome, not only from a love to the art of painting, but alſo to viſit his ſiſter, who was married to Nicholas Pouſſin. Sandrart ſays that Gaſpar was employed at firſt only to prepare the pallet, pencils, and colours, for Nicholas; but by the precepts and example of that excellent maſter, gradually roſe to the higheſt reputation, and is undoubtedly one of the beſt landſcape-painters that ever appeared. It is generally thought that no painter ever ſtudied nature to better purpoſe, or repreſented the effects of land-ſtorms more happily, than Gaſpar; all his trees ſhow a natural degree of agitation, every leaf being in motion; his ſcenes are all beautifully choſen, as are the ſites of his buildings. He deſigned human figures but very indifferently; for which reaſon he frequently prevailed on Nicholas to paint them for him; and they were always introduced with the utmoſt propriety. While he continued at Rome he dropped his own name, and aſſumed that of his brother-in-law and benefactor, by which only he is at preſent known. He died in 1662.

POWDER, in pharmacy, a dry medicine well broken, either in a mortar by grinding or by ſome chemical operation.

Gun-Powder. See GUNPOWDER. See alſo Obſervations on Gunpowder in the Iriſh Tranſactions 1788, p. 97. claſs *Science*, by Mr Napier.

Powder-Cheſts, certain ſmall boxes charged with powder and a quantity of old nails or ſplinters of iron, and faſtened occaſionally on the deck and ſides of a ſhip, in order to be diſcharged on an enemy who attempts to ſeize her by boarding. Theſe caſes are uſually

Powder || Power.

ally from 12 to 18 inches in length, and about eight or ten in breadth, having their outer or upper part terminating in an edge. They are nailed to several places of the quarter-deck and bulk-head of the waiſt, having a train of powder, which communicates with the inner apartments of the ſhip, ſo as to be fired at pleaſure to annoy the enemy. They are particularly uſed in merchant-ſhips which are furniſhed with cloſe-quarters to oppoſe the boarders.

Powder-Magazine, a bomb-proof arched building, to contain powder in fortified places.

Powder for the Hair. The beſt ſort is ſtarch well pounded and ſifted, and generally prepared with ſome perfume.

James's Powder. See *James's Powder*. In the Philoſophical Tranſactions for 1791, p. 317. there is a paper by Dr Pearſon, containing experiments and obſervations on James's powder. Dr Pearſon ſays, it was originally a patent medicine; but it is well known that it cannot be prepared by following the directions of the ſpecification in the court of chancery. His obſervations and experiments, therefore, he thinks, may explain the nature and manner of preparing this medicine, and perhaps may extend the hiſtory of antimony. The reſult of the whole, in Dr Pearſon's own words, is as follows:

1. James's powder conſiſts of phoſphoric acid, lime, and antimonial calx; with a minute quantity of calx of iron, which is conſidered to be an accidental ſubſtance. 2. Either theſe three eſſential ingredients are united with each other, forming a triple compound, or phoſphorated lime is combined with the antimonial calx, compoſing a double compound in the proportion of about 57 parts of calx and 43 parts of phoſphorated lime. 3. This antimonial calx is different from any other known calx of antimony in ſeveral of its chemical qualities. About three-fourths of it are ſoluble in marine acid, and afford Algaroth powder; and the remainder is not ſoluble in this menſtruum, and is apparently vitrified. It alſo appears, that by calcining together bone-aſhes, that is, phoſphorated lime and antimony in a certain proportion, and afterwards expoſing the mixture to a white heat, a compound was formed, conſiſting of antimonial calx and phoſphorated lime in the ſame proportion, and poſſeſſing the ſame kind of chemical properties as James's powder.

POWDIKE, in the fens of Norfolk and Ely. By ſtat. 22 Hen. VIII. c. 11. perverſely to cut down and deſtroy the powdike in the fens of Norfolk and Ely is felony. See *Blackſtone's Commentaries*, vol. iv. p. 243.

POWER, has been defined the faculty of doing or ſuffering any thing. Power, therefore, is two-fold, viz. conſidered as able to make, or able to receive, any change; the former whereof may be called *active*, and the latter *paſſive power*: but this diſtinction is improper. See METAPHYSICS, n° 116.

POWER, in mechanics, denotes any force, whether of a man, a horſe, a ſpring, the wind, water, &c. which, being applied to a machine, tends to produce motion.

POWER, in law, ſignifies in general a particular authority granted by any perſon to another to repreſent him, or to act in his ſtead.

POWERS, in arithmetic and algebra, are nothing but the products ariſing from the continual multiplications of a number or quantity into itſelf. See ALGEBRA and ARITHMETIC.

POX, *French-Pox*, or *Lues Venerea*. See MEDICINE, n° 350.

Pox || Præmunire.

Small-Pox. See INOCULATION, and MEDICINE, n° 222—226.

POYNING'S LAW, an act of parliament made in Ireland under Henry VII. whereby all the ſtatutes of force in England were made of force in Ireland; which before that time they were not.—Nor are any now in force there made in England ſince that time.

The law took its name from Sir Edward Poyning, lord-lieutenant of that kingdom at the time of its making. See IRELAND, n° 46.

POZZOLANA. See PUZZOLANA.

PRACTICE, in arithmetic. See there, n° 16. &c.

Gun-Practice, in military education. In the ſpring, as ſoon as the weather permits, the exerciſe of the great guns begins, with an intention to ſhow the gentlemen cadets at the royal military academy at Woolwich, and private men, the manner of laying, loading, pointing, and firing the guns. Sometimes inſtruments are uſed to find the centre line, or two points, one at the breech, the other at the muzzle, which are marked with chalk, and whereby the piece is directed to the target: then a quadrant is put into the mouth to give the gun the required elevation, which at firſt is gueſſed at, according to the diſtance the target is from the piece. When the piece has been fired, it is ſponged to clear it from any duſt or ſparks of fire that might remain in the bore, and loaded: then the centre line is found as before; and if the ſhot went too high or too low, to the right or to the left, the elevation and trail are altered accordingly. This practice continues morning and evening for about ſix weeks, more or leſs according as there are a greater or leſs number of recruits. In the mean time others are ſhown the motions of quick-firing with field-pieces.

Mortar-Practice, generally thus. A line of 1500 or 2000 yards is meaſured in an open ſpot of ground from the place where the mortars ſtand, and a flag fixed at about 300 or 500 yards: this being done, the ground where the mortars are to be placed is prepared and levelled with ſand, ſo that they may lie at an elevation of 45 degrees; then they are loaded with a ſmall quantity of powder at firſt, which is increaſed afterwards by an ounce every time, till they are loaded with a full charge; the times of the flights of the ſhells are obſerved, to determine the length of the fuzes. The intention of this practice is, when a mortar battery is raiſed in a ſiege, to know what quantity of powder is required to throw the ſhells into the works at a given diſtance, and to cut the fuzes of a juſt length, that the ſhell may burſt as ſoon as it touches the ground.

PRÆMUNIRE, in law, is taken either for a writ ſo called, or for the offence whereon the writ is granted; the one may be underſtood by the other.—The church of Rome, under pretence of her ſupremacy and the dignity of St Peter's chair, took on her to beſtow moſt of the eccleſiaſtical livings of any worth in England, by mandates, before they were void; pretending therein great care to ſee the church provided of a ſucceſſor before it needed. Whence theſe mandates or bulls were called *gratiæ expectativæ*, or *proviſiones*; whereof ſee a learned diſcourſe in *Duarenus de beneficiis*,

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beneficiis, lib. 3. cap. 1. Theſe proviſions were ſo common, that at laſt Edward I. not digeſting ſo intolerable an encroachment, in the 35th year of his reign made a ſtatute againſt papal proviſions, which, according to Sir Edward Coke, is the foundation of all the ſubſequent ſtatutes of præmunire: which is ranked as an offence immediately againſt the king, becauſe every encouragement of the papal power is a diminution of the authority of the crown.

In the weak reign of Edward II. the pope again endeavoured to encroach, but the parliament manfully withſtood him; and it was one of the articles charged againſt that unhappy prince, that he had given allowance to the bulls of the ſee of Rome. But Edw. III. was of a temper extremely different; and, to remedy theſe inconveniences, firſt by gentle means, he and his nobility wrote an expoſtulation to the pope: but receiving a menacing and contemptuous anſwer, withal acquainting him, that the emperor (who a few years before at the diet of Nuremberg, A. D. 1323, had eſtabliſhed a law againſt proviſions), and alſo the king of France, had lately ſubmitted to the holy ſee; the king replied, that if both the emperor and the French king ſhould take the pope's part, he was ready to give battle to them both, in defence of the liberties of the crown. Hereupon more ſharp and penal laws were deviſed againſt proviſors, which enact ſeverally, that the court of Rome ſhall preſent or collate to no biſhopric or living in England; and that whoever diſturbs any patron in the preſentation to a living by virtue of a papal proviſion, ſuch proviſor ſhall pay fine and ranſom to the king at his will, and be impriſoned till he renounces ſuch proviſion; and the ſame puniſhment is inflicted on ſuch as cite the king, or any of his ſubjects, to anſwer in the court of Rome. And when the holy ſee reſented theſe proceedings, and pope Urban V. attempted to revive the vaſſalage and annualrent to which king John had ſubjected his kingdom, it was unanimouſly agreed by all the eſtates of the realm in parliament aſſembled, 40 Edw. III. that king John's donation was null and void, being without the concurrence of parliament, and contrary to his coronation-oath; and all the temporary nobility and commons engaged, that if the pope ſhould endeavour by proceſs or otherwiſe to maintain theſe uſurpations, they would reſiſt and withſtand him with all their power.

In the reign of Richard II. it was found neceſſary to ſharpen and ſtrengthen theſe laws, and therefore it was enacted by ſtatutes 3 Ric. II. c. 3. and 7 Ric. II. c. 12. firſt, that no alien ſhall be capable of letting his benefice to farm; in order to compel ſuch as had crept in, at leaſt to reſide on their preferments: and afterwards, that no alien ſhould be capable to be preſented to any eccleſiaſtical preferment, under the penalty of the ſtatutes of proviſors. By the ſtatute 12 Rich. II. c. 15. all liegemen of the king accepting of a living by any foreign proviſion, are put out of the king's protection, and the benefice made void. To which the ſtatute 13 Rich. II. ſt. 2. c. 2. adds baniſhment and forfeiture of lands and goods: and by c. 3. of the ſame ſtatute, any perſon bringing over any citation or excommunication from beyond ſea, on account of the execution of the foregoing ſtatutes of proviſors, ſhall be impriſoned; forfeit his goods and lands, and moreover ſuffer pain of life and member.

7. In the writ for the execution of all theſe ſtatutes, the words *præmunire facias* being uſed to command a citation of the party, have denominated in common ſpeech, not only the writ, but the offence itſelf of maintaining the papal power, by the name of *præmunire*. And, accordingly, the next ſtatute we ſhall mention, which is generally referred to by all ſubſequent ſtatutes, is uſually called the *ſtatute of præmunire*. It is the ſtatute 16 Richard II. c. 5. which enacts, that whoever procures at Rome, or elſewhere, any tranſlations, proceſſes, excommunications, bulls, inſtruments, or other things which touch the king, againſt him, his crown, and realm, and all perſons aiding and aſſiſting therein, ſhall be put out of the king's protection, their lands and goods forfeited to the king's uſe, and they ſhall be attached by their bodies to anſwer to the king and his council; or proceſs of *præmunire facias* ſhall be made out againſt them as in other caſes of proviſors.

By the ſtatute 2 Henry IV. c. 3. all perſons who accept any proviſion from the pope, to be exempt from canonical obedience to their proper ordinary, are alſo ſubjected to the penalties of præmunire. And this is the laſt of our ancient ſtatutes touching this offence; the uſurped civil power of the biſhop of Rome being pretty well broken down by theſe ſtatutes, as his uſurped religious power was in about a century afterwards: the ſpirit of the nation being ſo much raiſed againſt foreigners, that about this time, in the reign of Hen. V. the alien priories, or abbeys for foreign monks, were ſuppreſſed, and their lands given to the crown. And no farther attempts were afterwards made in ſupport of theſe foreign juriſdictions.

This, then, is the original meaning of the offence which we call *præmunire*; viz. introducing a foreign power into this land, and creating *imperium in imperio*, by paying that obedience to papal proceſs which conſtitutionally belonged to the king alone, long before the Reformation in the reign of Henry VIII. at which time the penalties of præmunire were indeed extended to more papal abuſes than before; as the kingdom then entirely renounced the authority of the ſee of Rome, though not at all the corrupted doctrines of the Roman church. And therefore, by the ſeveral ſtatutes of 24 Hen. VIII. c. 12. and 25 Hen. VIII. c. 19. & 21. to appeal to Rome from any of the king's courts, which (though illegal before) had at times been connived at; to ſue to Rome for any licence or diſpenſation, or to obey any proceſs from thence, are made liable to the pains of præmunire. And, in order to reſtore to the king in effect the nomination of vacant biſhoprics, and yet keep up the eſtabliſhed forms, it is enacted by ſtatute 25 Hen. VIII. c. 20. that if the dean and chapter refuſe to elect the perſon named by the king, or any archbiſhop or biſhop to confirm or conſecrate him, they ſhall fall within the penalties of the ſtatutes of præmunire. Alſo by ſtatute 5 Eliz. c. 1. to refuſe the oath of ſupremacy will incur the pains of præmunire; and to defend the pope's juriſdiction in this realm, is a præmunire for the firſt offence, and high treaſon for the ſecond. So, too, by ſtatute 13 Eliz. c. 2. to import any *agnus Dei*, croſſes, beads, or other ſuperſtitious things pretended to be hallowed by the biſhop of Rome, and tender the ſame to be uſed; or to receive the ſame with ſuch intent, and not diſcover the offender; or if a juſtice of the peace, knowing thereof, ſhall not within

14.

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14 days declare it to a privy-counſellor, they all incur a præmunire. But importing or ſelling maſs-books, or other Popiſh books, is by ſtat. 3 Jac. I. c. 5. § 25. only liable to a penalty of 40 s. Laſtly, to contribute to the maintenance of a Jeſuit's college, or any Popiſh ſeminary whatever beyond ſea, or any perſon in the ſame, or to contribute to the maintenance of any Jeſuit or Popiſh prieſt in England, is by ſtatute 27 Eliz. c. 2. made liable to the penalties of præmunire.

Thus far the penalties of præmunire ſeem to have kept within the proper bounds of their original inſtitution, the depreſſing the power of the pope: but they being pains of no conſiderable conſequence, it has been thought fit to apply the ſame to other heinous offences; ſome of which bear more, and ſome leſs, relation to this original offence, and ſome no relation at all.

Thus, 1. By the ſtatute 1 & 2 Ph. and Mar. c. 8. to moleſt the poſſeſſors of abbey-lands granted by parliament to Henry VIII. and Edward VI. is a præmunire. 2. So likewiſe is the offence of acting as a broker or agent in any uſurious contract where above 10 *per cent.* intereſt is taken, by ſtatute 13 Eliz. c. 10. 3. To obtain any ſtay of proceedings, other than by arreſt of judgment or writ of error, in any ſuit for a monopoly, is likewiſe a præmunire, by ſtat. 21 Jac. I. c. 3. 4. To obtain an excluſive patent for the ſole making or importation of gunpowder or arms, or to hinder others from importing them, is alſo a præmunire by two ſtatutes; the one 16 Car. I. c. 21. the other 1 Jac. II. c. 8. 5. On the abolition, by ſtat. 12. Car. II. c. 24. of purveyance, and the prerogative of pre-emption, or taking any victual, beaſts, or goods for the king's uſe, at a ſtated price, without conſent of the proprietor, the exertion of any ſuch power for the future was declared to incur the penalties of præmunire. 6. To aſſert, maliciouſly and adviſedly, by ſpeaking or writing, that both or either houſe of parliament have a legiſlative authority without the king, is declared a præmunire by ſtatute 13 Car. II. c. 1. 7. By the *habeas corpus* act alſo, 31 Car. II. c. 2. it is a præmunire, and incapable of the king's pardon, beſides other heavy penalties, to ſend any ſubject of this realm a priſoner into parts beyond the ſeas. 8. By the ſtatute 1 W. & M. ſt. 1. c. 8. perſons of 18 years of age refuſing to take the new oaths of allegiance as well as ſupremacy, upon tender by the proper magiſtrate, are ſubject to the penalties of a præmunire; and by ſtatutes 7 & 8 W. III. c. 24. ſerjeants, counſellors, proctors, attorneys, and all officers of courts, practiſing without having taken the oaths of allegiance and ſupremacy, and ſubſcribed the declaration againſt popery, are guilty of a præmunire whether the oaths be tendered or not. 9. By the ſtatute 6 Ann. c. 7. to aſſert maliciouſly and directly, by preaching, teaching, or adviſed ſpeaking, that the then pretended prince of Wales, or any perſon other than according to the acts of ſettlement and union, hath any right to the throne of theſe kingdoms, or that the king and parliament cannot make laws to limit the deſcent of the crown; ſuch preaching, teaching, or adviſed ſpeaking, is a præmunire: as writing, printing, or publiſhing the ſame doctrines amounted, we may remember, to high treaſon. 10. By ſtatute 6 Ann. c. 23. if the aſſembly of peers of Scotland, convened to elect their 16 repreſentatives in the Britiſh parliament, ſhall preſume to treat of any other matter ſave only the election, they incur the penalties of a præmunire. 11. The ſtat. 6 Geo. I. c. 18. (enacted in the year after the infamous South Sea project had beggared half the nation) makes all unwarrantable undertakings by unlawful ſubſcriptions, then commonly known by the name of *bubbles*, ſubject to the penalties of a præmunire. 12. The ſtat. 12 Geo. III. c. 11. ſubjects to the penalties of the ſtatute of præmunire all ſuch as knowingly and wilfully ſolemnize, aſſiſt, or are preſent at, any forbidden marriage of ſuch of the deſcendants of the body of king Geo. II. as are by that act prohibited to contract matrimony without the conſent of the crown.

Præmunire, Præneſte.

Having thus inquired into the nature and ſeveral ſpecies of præmunire, its puniſhment may be gathered from the foregoing ſtatutes, which are thus ſhortly ſummed up by Sir Edward Coke: "That, from the conviction, the defendant ſhall be out of the king's protection, and his lands and tenements, goods and chattels, forfeited to the king; and that his body ſhall remain in priſon at the king's pleaſure, or (as other authorities have it) during life; both which amount to the ſame thing, as the king by his prerogative may any time remit the whole, or any part of the puniſhment, except in the caſe of tranſgreſſing the ſtatute of *habeas corpus*. Theſe forfeitures here inflicted do not (by the way) bring this offence within our former definition of FELONY; being inflicted by particular ſtatutes, and not by the common law." But ſo odious, Sir Edward Coke adds, was this offence of præmunire, that a man that was attainted of the ſame, might have been ſlain by any other man without danger of law; becauſe it was provided by law, that any man might do to him as to the king's enemy; and any man may lawfully kill an enemy. However, the poſition itſelf, that it is at any time lawful to kill an enemy, is by no means tenable: it is only lawful, by the law of nature and nations, to kill him in the heat of battle, or for neceſſary ſelf-defence. And to obviate ſuch ſavage and miſtaken notions, the ſtatute 5 Eliz. c. 1. provides, that it ſhall not be lawful to kill any perſon attainted in a præmunire, any law, ſtatute, opinion, or expoſition of law to the contrary notwithſtanding. But ſtill ſuch delinquent, though protected as a part of the public from public wrongs, can bring no action for any private injury, how atrocious ſoever; being ſo far out of the protection of the law, that it will not guard his civil rights, nor remedy any grievance which he as an individual may ſuffer. And no man, knowing him to be guilty, can with ſafety give him comfort, aid, or relief.

PRÆNESTE (anc. geog.), a town of Latium, to the ſouth-eaſt of Rome, towards the territory of the Æqui; a place of great ſtrength. Famous for the temple and oracle of Fortune, called *Sortes Prænęſtinæ* (Strabo); which Tiberius wanted to deſtroy, but was deterred by the awful majeſty of the place. From a colony it was raiſed to a municipium by Tiberius (Inſcriptions, Florus, A. Gellius), on the conſideration of his recovery from a dangerous illneſs near this place. Thither the Roman emperors uſually retired, on account of the agreeableneſs of the ſituation (Suetonius). It was a very ancient city, with a territory of large extent (Livy). The temple of Fortune was built in the moſt ſumptuous manner by Sylla, and the pavement was Moſaic work (Pliny). Concerning the Sortes, there is a remarkable paſſage in Cicero; who ſays, that it was all

Præſidium || Prague.

a mere contrivance, in order to deceive, either for the purpoſes of gain or ſuperſtition. The town that has ſucceeded it ſtands low in a valley, and is called *Paleſtrina*, in the Campania of Rome. E. Long. 13. 30. N. Lat. 42. 0.

PRÆSIDIUM (Notitia), a town of the Cornavii in Britain. Now thought to be Warwick (Camden).—Another of Corſica (Antonine), 30 miles to the ſouth of Aleria.—A third *Præſidium* furnamed *Julium*, in Bætica (Pliny).

PRÆTORIA AUGUSTA (Ptolemy), a town of Dacia. Now called *Braſſow* by the natives, and *Cronſtat* by the Germans (Baudrand): a town in Tranſylvania. E. Long. 25°. N. Lat. 47°.—Another of the Salaſſii, near the two gates or defiles of the Alps, the Grajæ and Penninæ (Pliny); a Roman colony, ſettled by Auguſtus after the defeat of the Salaſſii by Terentius Varro, on the ſpot where he encamped (Strabo, Dio Caſſius, Ptolemy), ſituated on the river Duria Major. The town is now called *Aoſta* or *Aouſt*, in Piedmont. E. Long. 7. 14. N. Lat. 45. 19.

PRÆTORIUM (Antonine, Notitia Imperii), a town of the Brigantes. Now *Paterington* (Camden), near the mouth of the Humber in Yorkſhire. *Coventry* (Talbot).

PRAGMATIC SANCTION, in the civil law, is defined by Hottoman to be a reſcript or anſwer of the ſovereign, delivered by advice of his council, to ſome college, order, or body of people, upon conſulting him on ſome caſe of their community. The like anſwer given to any particular perſon is called ſimply *reſcript*.

The term *pragmatic ſanction* is chiefly applied to a ſettlement of Charles VI. emperor of Germany, who, in the year 1722, having no ſons, ſettled his hereditary dominions on his eldeſt daughter the archduchess Maria Thereſa, which was confirmed by the diet of the empire, and guaranteed by Great Britain, France, the States-General, and moſt of the powers in Europe. The word *pragmatic* is derived from the Greek πραγμα, *negotium*, "buſineſs."—It is ſometimes alſo called abſolutely *pragmatic*, το πραγματικον.

PRAGUE, a city of Bohemia, and capital of the whole kingdom, is ſituated 14° 40′ of longitude, and 50° 5′ of latitude. It ſtands on both ſides the Moldau, over which there is a bridge 700 feet long, built of large freeſtone. The river, though of great breadth here, is nevertheleſs ſhallow, and not navigable. On both ſides the bridge are ſeveral ſtatues, and among others that of St John of Nepomuck, whom king Wenſel cauſed to be thrown from the bridge into the river, for venturing to reprove him upon ſome occaſion; but in 1720 he was canonized as a ſaint, and is at preſent held in ſuch veneration in Bohemia, that all other ſaints ſeem on his account to be forgotten. Near the bridge, which ſtands at the upper part of the city, the number of people is very great, but the further you go from thence the more deſolate you find every place. The city is about three miles long and two broad; the number of its Chriſtian inhabitants is ſaid to be 70,000, and of Jews about 12,000. The principal branch of its trade conſiſts in brewing of beer. It is divided into the Old and the New Towns, and that called the *Small ſide*; the former lying on the eaſt ſide of the Moldau, and the latter on the weſt. The whole is about 12 miles in circumference. The fortifications are not of great importance, as it may be flanked and raked on all ſides. However, the king of Pruſſia was not able to make himſelf maſter of it in the late war, though he almoſt deſtroyed it with his bombs, &c. See PRUSSIA, n° 24, &c.—It hath ſuffered greatly by ſieges, and hath been often taken and plundered. The univerſity was founded by Charles IV. in the year 1347. In 1409, when John Huſs was rector of the univerſity, there were no leſs than 44,000 ſtudents; and when the emperor Charles V. would have retrenched their priviledges, 24,000 are ſaid to have left it in one week, and 16,000 in a ſhort time after. The Jews have the trade of this city almoſt entirely in their own hands. They deal in all ſorts of commodities, eſpecially the precious ſtones found in the Bohemian mines, and, by receiving all old-faſhioned things in payment, quite ruin the Chriſtian handicraftſmen. In 1744 they narrowly eſcaped being expelled the kingdom, having been ſuſpected of correſponding with the Pruſſians, when they made themſelves maſters of the city. The grand prior of the order of Malta, for Bohemia, Moravia, and Sileſia, reſides here; and the church and hoſpital of the Holy Ghoſt is the ſeat of the general and grandmaſters of the holy order of knights of the croſs with the red ſtar, reſiding in the above-mentioned countries, and in Poland and Hungary. The houſes of this city are all built of ſtone, and generally conſiſt of three ſtories; but there are very few good buildings in it, and almoſt every thing looks dirty. The cathedral, which is dedicated to St Veit, is an old building, in which there are ſome pieces of excellent architecture and many magnificent tombs of great men. There are 100 churches and chapels, and about 40 cloiſters in the place. On Ratſchin-hill, in Upper Prague, moſt of the nobility have houſes, and the emperor a very magnificent palace, and a ſummer-houſe commanding one of the fineſt proſpects in the world. Here the tribunals of the regency meet; and the halls, galleries, and other apartments, are adorned with a multitude of noble pictures. The great hall, where the coronation feaſt is kept, is ſaid to be the largeſt of the kind in Europe next to that of Weſtminſter. The caſtle ſtands on the above-mentioned mountain, called *Ratſchin* or the *White Mountain*, and is very ſtrong. From a window of this caſtle the emperor's counſellors were thrown in 1618; but though they fell from a great height, yet they were not killed, nor indeed much hurt. On the ſame mountain ſtands alſo the archiepiſcopal palace. In the New Town is an arſenal, and a religious foundation for ladies, called the *Free Temporal Engliſh Foundation*, over which an abbeſs preſides. In the Leſſer Side or Town, the counts Colloredo and Wallenſtein have very magnificent palaces and gardens. The ſtables of the latter are very grand; the racks being of ſteel and the mangers of marble, and a marble pillar betwixt each horſe; over each horſe alſo is placed his picture as big as life. Though the inhabitants of Prague in general are poor, and their ſhops but meanly furniſhed, yet, it is ſaid, there are few cities where the nobility and gentry are more wealthy, and live in greater ſtate. Here is much gaming, maſquerading, feaſting, and very ſplendid public balls, with an Italian opera, and aſſemblies in the houſes of the quality every night. On the White Mountain, near the town, was fought the battle in which the Proteſtants, with the elector Palatine Frederic their king, were defeated.

Prague.

Pram || Pratt.

The luſtres and drinking-glaſſes made here of Bohemian cryſtal are much eſteemed, and vended all over Europe. Theſe cryſtals are alſo poliſhed by the Jews, and ſet in rings, ear-pendants, and ſhirt-buttons. The chief tribunal conſiſts of twelve ſtadtholders, at the head of whom is the great burgrave, governor of the kingdom and city, immediately under the emperor, and the chancery of Bohemia. Though the city of Prague is very ill-built, it is pleaſantly ſituated, and ſome of the proſpects are beautiful, and the gardens and pleaſure-houſes are excellent. The people, Rieſbeck informs us, enjoy ſenſual pleaſures more than thoſe of Vienna, becauſe they know better how to connect mental enjoyments with them. The numerous garriſon kept in the place (9000 men) contributes much to its gaiety and livelineſs.

PRAM, or PRAME, a kind of lighter uſed in Holland and the ports of the Baltic Sea, to carry the cargo of a merchant-ſhip *along-ſide*, in order to lade or to bring it to ſhore to be lodged in the ſtorehouſes after being diſcharged out of the veſſel.

PRAME, in military affairs, a kind of floating battery, being a flat-bottomed veſſel, which draws little water, mounts ſeveral guns, and is very uſeful in covering the diſembarkation of troops. They are generally made uſe of in tranſporting troops over the lakes in America.

PRAMNION, in natural hiſtory, the name of a ſemipellucid gem. This is a very ſingular ſtone, and of a very great concealed beauty. Our lapidaries, when they meet with it, call it by the name of the *black agate*. It is of an extremely cloſe, compact, and firm texture, of a ſmooth and equal ſurface, and in ſhape very irregular, being ſometimes round, ſometimes oblong, and often flat; in ſize it ſeldom exceeds two inches. It appears, on a common inſpection, to be of a fine deep black; but held up againſt the ſun or the light of a candle, it is an elegant red, clouded by a quantity of ſubtile black earth. We have it from the Eaſt Indies.

PRASIUM, in botany: A genus of the gymnoſpermia order, belonging to the didynamia claſs of plants; and in the natural method ranking under the 42d order, *Verticillatæ*. There are four monoſpermous berries.

PRATINAS, a Greek poet contemporary with Æſchylus, born at Phlius. He was the firſt among the Greeks who compoſed ſatires, which were repreſented as farces. Of theſe 32 were acted, as alſo 18 of his tragedies, one of which only obtained the poetical prize. Some of his verſes are extant, quoted by Athenæus.

PRATIQUE, or PRATTIC, in commerce, a negociation or communication of commerce which a merchant veſſel obtains in the port it arrives in and the countries it diſcovers: hence to obtain a pratique, is to obtain liberty to frequent a port, to go aſhore, to buy and ſell, &c.

PRATT (Charles), earl of Camden, was the third ſon of Sir John Pratt, knight, chief-juſtice of the court of king's-bench under George I. by his ſecond wife Elizabeth, daughter of the Reverend Hugh Wilſon canon of Bangor, and was born in 1713, the year before his father was called to the honour of the bench. He received the firſt rudiments of his education at Eton, and afterwards removed to king's college Cambridge. Of his early life at both places there is little known, other than that at college he was found to be remarkably diligent and ſtudious, and particularly ſo in the hiſtory and conſtitution of this country. By ſome he was thought to be a little too tenacious of the rights and privileges of the college he belonged to; but perhaps it was to this early tendency that we are indebted for thoſe noble ſtruggles in defence of liberty, which, whether in or out of office, he diſplayed through the whole courſe of his political life. After ſtaying out the uſual time at college, and taking his maſter's degree, in 1739 he entered himſelf a ſtudent of the Inner Temple, and was in due time admitted by that honourable ſociety as a barriſter at law. And here a circumſtance developes itſelf in the hiſtory of this great man, which ſhows how much chance governs in the affairs of this world, and that the moſt conſiderable talents and indiſputable integrity will ſometimes require the introduction of this miſtreſs of the ceremonies, in order to obtain that which they ought to poſſeſs from their own intrinſic qualifications.

Pratt.

Mr Pratt, after his being called to the bar, notwithſtanding his family introduction, and his own perſonal character, was very near nine years in the profeſſion, without ever getting in any degree forward. Whether this aroſe from a natural timidity of conſtitution, ill-luck, or perhaps a mixture of deſpondence growing out of the two circumſtances, it is now difficult to tell; but the fact was ſo: and he was ſo diſpirited by it, that he had ſome thoughts of relinquiſhing the profeſſion of the law, and retiring to his college, where, in rotation, he might be ſure of a church living, that would give him a ſmall but honourable independence. With theſe melancholy ideas he went as uſual the weſtern circuit, to make one more experiment, and then to take his final determination. Mr Henley, afterwards Lord Northington and chancellor of England, was in the ſame circuit: he was Mr Pratt's moſt intimate friend; and he now availed himſelf of that friendſhip, and told him his ſituation, and his intentions of retiring to the univerſity and going into the church. He oppoſed his intention with ſtrong raillery, and got him engaged in a cauſe along with himſelf; and Mr Henley being ill, Mr Pratt took the lead, and diſplayed a profeſſional knowledge and elocution that excited the admiration of his brother barriſters as much as that of the whole court. He gained his cauſe; and beſides, he acquired the reputation of an eloquent, profound, and conſtitutional lawyer. It was this circumſtance, together with the continued good offices of his friend Henley, which led to his future greatneſs; for with all his abilities and all his knowledge, he might otherwiſe in all probability have paſſed his life in obſcurity unnoticed and unknown.

He became now one of the moſt ſucceſsful pleaders at the bar, and honours and emoluments flowed thick upon him. He was choſen to repreſent the borough of Downton, Wilts, after the general election in 1759; recorder of Bath 1759; and the ſame year was appointed attorney-general; in January 1762 he was called to the degree of ſerjeant at law, appointed chief-juſtice of the common pleas, and knighted. His Lordſhip preſided in that court with a dignity, weight, and impartiality, never exceeded by any of his predeceſſors; and when John Wilkes, Eſq; was ſeized and committed to the Tower on an illegal

general

Pratt. general warrant, his Lordſhip, with the intrepidity of a Britiſh magiſtrate, and the becoming fortitude of an Engliſhman, granted him an *habeas corpus*; and on his being brought before the court of common pleas, diſcharged him from his confinement in the Tower, May 6. 1763, in a ſpeech which did him honour. His wiſe and ſpirited behaviour on this remarkable occaſion, ſo intereſting to every true-born Briton, and in the conſequent judicial proceedings between the printers of The North Briton and the meſſengers and others, was ſo acceptable to the nation, that the city of London preſented him with the freedom of their corporation in a gold box, and deſired his picture, which was put up in Guildhall, with this inſcription:

HANC ICONEM
CAROLI PRATT, EQ.
SUMMI JUDICIS C. B.
IN HONOREM TANTI VIRI,
ANGLICÆ LIBERTATIS LEGE
ASSERTORIS,
S. P. Q. L.
IN CURIA MUNICIPALI
PONI JVSSERVNT
NONO KAL. MART. A. D. MDCCLXIV.
GULIELMO BRIDGEN, AR. PRÆ. VRB.

This portrait, painted by Reynolds, was engraved by Baſire. The corporations of Dublin, Bath, Exeter, and Norwich, paid him the like compliment; and in a petition entered in the journals of the city of Dublin, it was declared, that no man appeared to have acquitted himſelf in his high ſtation with ſuch becoming zeal for the honour and dignity of the crown, and the fulfilling his majeſty's moſt gracious intentions for preſerving the freedom and happineſs of his ſubjects, and ſuch invincible fortitude in adminiſtering juſtice and law, as the Right Honourable Sir Charles Pratt, knight, the preſent lord-chief-juſtice of his majeſty's court of common pleas in England, has ſhown in ſome late judicial determinations, which muſt be remembered to his lordſhip's honour while and wherever Britiſh liberties are held ſacred.

Higher honours, however, than the breath of popular applauſe awaited Sir Charles Pratt. On the 16th of July 1765 he was created a peer of Great Britain, by the ſtyle and title of Lord Camden, Baron Camden, in the county of Kent; and, July 30. 1766, on the reſignation of Robert earl of Northington, he was appointed lord high-chancellor of Great Britain; in which capacity he, in a ſpeech of two hours, declared, upon the firſt deciſion of the ſuit againſt the meſſengers who arreſted Mr Wilkes, that "it was the unanimous opinion of the whole court, that general warrants, except in caſes of high treaſon, were illegal, oppreſſive, and unwarrantable. He conducted himſelf in this high office ſo as to obtain the love and eſteem of all parties; but when the taxation of America was in agitation, he declared himſelf againſt it, and ſtrongly oppoſing it, was removed from his ſtation in 1770.

Upon the fall of Lord North he was again taken into the adminiſtration, and on the 27th of March 1782 appointed preſident of the council; an office which he reſigned in March 1783. On the 13th of May 1786, he was created Viſcount Bayham of Bayham abbey Kent, and Earl Camden.

Whether we conſider Earl Camden as a *ſtateſman*, called to that high ſituation by his talents; as a *lawyer*, defending, ſupporting, and enlarging the conſtitution; or as a *man* ſuſtaining both by his firmneſs and unſhaken integrity—in all he excites our general praiſe; and when we contemplate his high and exalted virtue, we muſt allow him to have been an honour to his country. He died on the 18th of April 1794 at his houſe in Hill-ſtreet, Berkeley-ſquare, being at that time preſident of his majeſty's moſt honourable privy-council, a governor of the charter-houſe, recorder of the city of Bath, and F. R. S. Pratt ‖ Prayer.

He married Elizabeth, daughter and coheir of Nicholas Jafferys, Eſq; ſon and heir of Sir Jeffery Jafferys of Brecknock priory, knight, who died in December 1779, and by whom he had iſſue John Jafferys Pratt (now Lord Camden), born 1759, M. P. for Bath, commiſſioner of the admiralty, 1782, reſigned and reappointed 1783; and four daughters, Frances, married, 1775, Robert Stewart, Eſq; of Mount Stewart, county of Down, 1779, and M. P. for that county; Elizabeth, ſingle; Sarah, married Nicholas Saintfield, Eſq; county of Down, 1779; Jane, married 1780 William Head James, Eſq; ſon and heir of Sir F. Head of Langley, county of Bucks. His ſeat at Camden place, Chiſelhurſt, was the reſidence of the great William Camden; on whoſe death it came by ſeveral intermediate owners to Weſton, Spencer, and Pratt, and was much improved by his Lordſhip. His remains were interred in the family burying-place at Seal, in Kent.

PRAXAGORAS, a native of Athens, at 19 years of age compoſed the Hiſtory of the Kings of Athens, in two books; and at 22 the Life of Conſtantine the Great, in which, though a pagan, he ſpeaks very advantageouſly of that prince. He alſo wrote the Hiſtory of Alexander the Great. He lived under Conſtantius about the year 345.

PRAXITELES, a very famous Greek ſculptor, who lived 330 years before Chriſt, at the time of the reign of Alexander the Great. All the ancient writers mention his ſtatues with a high commendation, eſpecially a Venus executed by him for the city of Cnidos, which was ſo admirable a piece, that king Nicomedes offered to releaſe the inhabitants from their tribute as the purchaſe of it; but they refuſed to part with it. The inhabitants of the iſle of Cos requeſted of Praxiteles a ſtatue of Venus; and in conſequence of this application the artiſt gave them their choice of two; one of which repreſented the goddeſs entirely naked, and the other covered with drapery. Both of theſe were of exquiſite workmanſhip; although the former was eſteemed the moſt beautiful, nevertheleſs the inhabitants of Cos had the wiſdom to give the preference to the latter, from a conviction that no motive whatever could juſtify their introducing into their city any indecent ſtatues or paintings, which are ſo likely to inflame the paſſions of young people, and lead them to immorality and vice. What a reproach will this be to many Chriſtians!—He was one of the gallants of Phryne the celebrated courteſan.

PRAYER, a ſolemn addreſs to God, which, when it is of any conſiderable length, conſiſts of *adoration*, *confeſſion*, *ſupplication*, *interceſſion*, and *thankſgiving*.

By *adoration* we expreſs our ſenſe of God's infinite perfections, his power, wiſdom, goodneſs, and mercy; and acknowledge that our conſtant dependence is upon Him by whom the univerſe was created and has been

Prayer

hitherto preſerved. By *confeſſion* is meant our acknowledgment of our manifold tranſgreſſions of the divine laws, and our conſequent unworthineſs of all the good things which we enjoy at preſent or expect to be conferred upon us hereafter. In *ſupplication* we intreat our omnipotent Creator and merciful Judge, not to deal with us after our iniquities, but to pardon our tranſgreſſions, and by his grace to enable us to live henceforth righteouſly, ſoberly, and godly, in this preſent world; and by Chriſtians this intreaty is always made in the name and through the mediation of Jeſus Chriſt, becauſe to them it is known that there is none other name under heaven given unto men whereby they may be ſaved. To theſe ſupplications for mercy we may likewiſe add our prayers for the neceſſaries of life; becauſe if we ſeek *firſt* the kingdom of God and his righteouſneſs, we are aſſured that ſuch things ſhall be added unto us. *Interceſſion* ſignifies thoſe petitions which we offer up for others, for friends, for enemies, for all men, eſpecially for our lawful governors, whether ſupreme or ſubordinate. And *thankſgiving* is the expreſſion of our gratitude to God, the giver of every good and perfect gift, for all the benefits enjoyed by us and others, for the means of grace, and for the hope of glory. Such are the component parts of a regular and ſolemn prayer, adapted either for the church or for the cloſet. But an ejaculation to God, conceived on any emergency, is likewiſe a prayer, whether it be uttered by the voice or ſuffered to remain a mere affection of the mind; becauſe the Being to whom it is addreſſed diſcerneth the thoughts of the heart.

That prayer is a duty which all men ought to perform with humility and reverence, has been generally acknowledged as well by the untaught barbarian as by the enlightened Chriſtian; and yet to this duty objections have been made by which the underſtanding has been bewildered in ſophiſtry and affronted with jargon. "If God be independent, omnipotent, and poſſeſſed of every other perfection, what pleaſure, it has been aſked, can he take in our acknowledgment of theſe perfections? If he knows all things paſt, preſent, and future, where is the propriety of our confeſſing our ſins unto him? If he is a benevolent and merciful Being, he will pardon our ſins, and grant us what is needful for us without our ſupplications and intreaties; and if he be likewiſe poſſeſſed of infinite wiſdom, it is certain that no importunities of ours will prevail upon him to grant us what is improper, or for our ſakes to change the equal and ſteady laws by which the world is governed.

"Shall burning Ætna, if a ſage requires,
"Forget to thunder, and recal her fires?
"On air or ſea new motions be impreſt,
"Oh blameleſs Bethel! to relieve thy breaſt?
"When the looſe mountain trembles from on high,
"Shall gravitation ceaſe, if you go by?
"Or ſome old temple, nodding to its fall,
"For Chartres' head reſerve the hanging wall*?"

*Eſſay on Man.

Such are the moſt plauſible objections which are uſually made to the practice of prayer; and though they have been ſet off with all the art of the metaphyſical wrangler, and embelliſhed with all the graces of the poetry of Pope, they appear to us ſuch groſs ſophiſms as can operate only on a very unthinking head, or on a very corrupt heart. For if God certainly exiſts, and there is not a mathematical theorem capable of more rigid demonſtration, it is obvious that no man can think of ſuch a being without having his mind ſtrongly impreſſed with the conviction of his own conſtant dependence upon him; nor can he "contemplate the heavens, the work of God's hands, the moon, and the ſtars which he has ordained," without forming the moſt ſublime conceptions that he can of the Divine power, wiſdom, and goodneſs, &c. But ſuch conviction, and ſuch conceptions, whether clothed in words or not, are to all intents and purpoſes what is meant by adoration; and are as well known to the Deity while they remain the ſilent affections of the heart, as after they are ſpoken in the beginning of a prayer. Our adoration, therefore, is not expreſſed for the purpoſe of giving information to God, who underſtandeth our thoughts afar off; but merely, when the prayer is private, becauſe we cannot think any more than ſpeak without words, and becauſe the very *ſound* of words that are well choſen affects the heart, and helps to fix our attention: and as the Being who ſees at once the paſt, preſent, and to come, and to whom a thouſand years are but as one day, ſtands not in need of our information; ſo neither was it ever ſuppoſed by a man of rational piety, that he takes pleaſure on his *own* account in hearing his perfections enumerated by creatures of yeſterday; for being independent, he has no paſſions to be gratified, and being ſelf-ſufficient, he was as happy when exiſting alone as at that moment "when the morning ſtars ſang together, and all the ſons of God ſhouted for joy." Adoration is therefore proper only as it tends to preſerve in our minds juſt notions of the Creator and Governor of the world, and of our own conſtant dependence upon him; and if ſuch notions be uſeful to ourſelves, who have a part to act in the ſcale of exiſtence, upon which our happineſs depends (a propoſition which no theiſt will controvert), adoration muſt be acceptable to that benevolent God, who, when creating the world, could have no other end in view than to propagate happineſs. See METAPHYSICS, n° 312.

By the ſame mode of reaſoning, it will be eaſy to ſhow the duty of *confeſſion* and *ſupplication*. We are not required to confeſs our ſins unto God, becauſe he is ignorant of them; for he is ignorant of nothing. If he were, no reaſon could be aſſigned for our divulging to our judge actions deſerving of puniſhment. Neither are we required to cry for mercy, in order to move him in whom there is no variableneſs, neither ſhadow of turning. The Being that made the world, governs it by laws that are inflexible, becauſe they are the beſt; and to ſuppoſe that he can be induced by prayers, oblations, or ſacrifices, to vary his plan of government, is an impious thought, which degrades the Deity to a level with man. One of theſe inflexible laws is the connection eſtabliſhed between certain diſpoſitions of mind and human happineſs. We are enjoined to purſue a particular courſe of conduct under the denomination of virtue, not becauſe our virtuous actions can in any degree be of advantage to him by whom we were created, but becauſe they neceſſarily generate in our own minds thoſe diſpoſitions which are eſſential to our ultimate happineſs. A man of a malignant, arrogant, or ſenſual diſpoſition, would have no enjoyment in that heaven, where all are actuated by a ſpirit of love and purity; and it is doubtleſs for this reaſon omong others, that the Chriſtian religion prohibits

Prayer. prohibits malice, arrogance, and ſenſuality, among her votaries, and requires the cultivation of the oppoſite virtues. But a perſon who has deviated far from his duty cannot think of returning, unleſs he be previouſly convinced that he has gone aſtray. Such conviction, whenever he obtains it, will neceſſarily impreſs upon his mind a ſenſe of his own danger, and fill his heart with ſorrow and remorſe for having tranſgreſſed the laws eſtabliſhed by the moſt benevolent of all Beings for the propagation of univerſal felicity. This convicton of error, this ſenſe of danger, and this compunction for having tranſgreſſed, are all perceived by the Deity as ſoon as they take place in the mind of the ſinner; and he is required to *confeſs* his ſins, only becauſe the act of confeſſion tends to imprint more deeply on his mind his own unworthineſs, and the neceſſity of returning immediately into the paths of that virtue of which all the ways are pleaſentneſs and all the paths are peace.

In the objection, it is taken for granted, that if God be a benevolent and merciful Being, he will pardon our ſins, and grant us what is needful for us, whether we ſupplicate him or not: but this is a groſs and palpable miſtake, ariſing from the objector's ignorance of the end of virtue and the nature of man. Until a man be ſenſible of his ſins and his danger, he is for the reaſon already aſſigned incapable of pardon, becauſe his diſpoſition is incompatible with the happineſs of the bleſſed. But whenever he acquires this conviction, it is impoſſible for him not to form a *mental wiſh* that he may be pardoned; and this wiſh being perceptible to the all-ſeeing eye of his Judge, forms the ſum and ſubſtance of a ſupplication for mercy. If he clothe it in words, it is only for a reaſon ſimilar to that which makes him adore his Creator and confeſs his ſins in words, that juſt notions may be more deeply imprinted on his own mind. The ſame reaſoning holds good with reſpect to thoſe prayers which we put up for temporal bleſſings, for protection and ſupport in our journey through life. We are told by high authority, that "the Lord is nigh unto all them that call upon him, to all that call upon him in truth." This, however, is not becauſe he is attracted or delighted by their prayers and intreaties, but becauſe thoſe prayers and intreaties fit ſuch as offer them for receiving thoſe benefits which he is at all times ready to pour upon all mankind. In his eſſence God is equally preſent with the righteous and with the wicked, with thoſe who pray, and with thoſe who pray not; for "the eyes of the Lord are in every place beholding the evil and the good." But as the atmoſphere equally ſurrounds every perſon upon this globe, and yet in its ſtate of greateſt purity does not affect the aſthmatic as it affects thoſe who are whole; ſo the Divine preſence, though eſſentially the ſame everywhere, yet does not protect the impious as it protects the devout, becauſe the impious are not in a ſtate capable of the Divine protection. The end for which God requires the exerciſe of prayer as a duty, is not his benefit but ours; becauſe it is a mean to generate in the petitioner ſuch a diſpoſition of mind as muſt render him a ſpecial object of that love and that providential care which extend over the whole creation.

That part of the objection which reſults from the conſideration of the fixed laws of nature, and which the poet has ſo finely illuſtrated, preſents, it muſt be confeſſed, conſiderable difficulties; but none which to us appear inſurmountable. If, indeed, we ſuppoſe that in the original conſtitution of things, when the laws of nature were eſtabliſhed, a determinate duration was given to the top of the mountain and the nodding temple, without any regard to foreſeen conſequences, it would undoubtedly be abſurd and perhaps impious to expect the law of gravitation to be ſuſpended by the prayers of a good man, who ſhould happen to be paſſing at the inſtant decreed for the fall of theſe objects. But of ſuch a conſtitution there is ſo far from being evidence, that it appears not to be conſiſtent with the wiſdom and goodneſs of the Author of nature. This world was undoubtedly formed for the habitation of man and of other animals. If ſo, we muſt neceſſarily ſuppoſe, that in the eſtabliſhing of the laws of nature, God adjuſted them in ſuch a manner as he ſaw would beſt ſerve the accommodation of thoſe ſentient beings for whoſe accommodation alone they were to be eſtabliſhed. Let it then be admitted, that all the human beings who were ever to exiſt upon this globe, with all their thoughts, words, and actions, were at that important moment preſent to the divine intellect, and it ſurely will not be impoſſible to conceive, that in conſequence of the foreſeen danger and prayers of a good man, the determinate duration of the mountain and the tower might be either lengthened or ſhortened to let him eſcape. This idea of providence, and of the efficacy of prayer, is thus illuſtrated by Mr Wollaſton *. "Suppoſe M (ſome man) certainly to *foreknow*, by ſome means or other, that, when he ſhould come to be upon his death-bed, L would *petition* for ſome *particular legacy*, in a manner ſo earneſt and humble, and with ſuch a good diſpoſition, as would render it proper to grant his requeſt: and upon this, M makes his *laſt will*, by which he deviſes to L that which was to be aſked, and then locks up the *will*; and all this many years before the death of M, and whilſt L had yet no expectation or thought of any ſuch thing. When the time comes, the *petition* is made and *granted*; not by making any *new* will, but by the old one already made, and without alteration: which legacy had, notwithſtanding that, never been left, had the petition never been preferred. The grant may be called the effect of a future act, and depends as much upon it as if it had been made after the act. So, if it had been foreſeen, that L would not *ſo much as aſk*, and he had been therefore left out of the will, this *præterition* would have been cauſed by his carriage, though much later than the date of the will. In all this nothing is hard to be admitted, if M be allowed to foreknow the caſe. And thus the *prayers* which good men offer to the *all-knowing* God, and the *neglect of prayers* by others, may find fitting effects *already* forecaſted in the courſe of nature."

Prayer.

* *Religion of Nature delineated.*

This ſolution of the difficulty preſents indeed to the mind a prodigious ſcheme, in which all things to come are, as it were, comprehended under one view, and eſtimated and compared together. But when it is conſidered what a maſs of wonders the univerſe is in other reſpects; what an incomprehenſibly great and perfect Being God is; that he cannot be ignorant of any thing, no not of the future wants and deportments of particular men; and that all things which derive their exiſtence from him muſt be conſiſtent with one another—it muſt ſurely be confeſſed that ſuch an adjuſtment of phyſical cauſes to moral volitions is within the compaſs of infinite power and perfect wiſdom.

To

Prayer. To that part of a prayer which we have termed interceſſion, it has been objected, that "to intercede for others is to preſume that we poſſeſs an intereſt with the Deity upon which their happineſs and even the proſperity of whole communities depends." In anſwer to this objection, it has been obſerved by an ingenious and uſeful writer †, that "how unequal ſoever our knowledge of the divine economy may be to a complete ſolution of this difficulty, which may require a comprehenſion of the entire plan, and of all the ends of God's moral government, to explain it ſatisfactorily, we can yet underſtand one thing concerning it, that it is, after all, nothing more than the making of one man the inſtrument of happineſs and miſery to another; which is perfectly of a piece with the courſe and order that obtain, and which we muſt believe were intended to obtain in human affairs. Why may we not be aſſiſted by the *prayers* of other men, as well as we are beholden for our *ſupport to their labour?* Why may not our happineſs be made in ſome caſes to depend upon the interceſſion as it certainly does in many upon the good offices of our neighbours? The happineſs and miſery of great numbers we ſee oftentimes at the diſpoſal of one man's choice, or liable to be much affected by his conduct: what greater difficulty is there in ſuppoſing, that the prayers of an individual may avert a calamity from multitudes, or be accepted to the benefit of whole communities."

† *Mr Paley.*

Theſe obſervations may perhaps be ſufficient to remove the force of the objection, but much more may be ſaid for the practice of mutual interceſſion. If it be one man's duty to intercede for another, it is the duty of that other to intercede for him; and if we ſet aſide the particular relations which ariſe from blood, and from particular ſtations in ſociety, mutual interceſſion muſt be equally the duty of all mankind. But there is nothing (we ſpeak from our own experience, and appeal to the experience of our readers) which has ſo powerful a tendency to generate in the heart of any perſon good-will towards another as the conſtant practice of praying to God for his happineſs. Let a man regularly pray for his enemy with all that ſerioufneſs which devotion requires, and he will not long harbour reſentment againſt him. Let him pray for his friend with that ardour which friendſhip naturally inſpires, and he will perceive his attachment to grow daily and daily ſtronger. If, then, univerſal benevolence, or charity, be a diſpoſition which we ought to cultivate in ourſelves, mutual interceſſion is undeniably a duty, becauſe nothing contributes ſo effectually to the acquiſition of that ſpirit which an apoſtle terms the end of the commandment.

When it is ſaid, that by interceding for kings, and all in authority, we ſeem to conſider the proſperity of communities as depending upon our intereſt with God, the objector miſtakes the nature and end of theſe interceſſions. In the proſperity of any community conſiſts great part of the happineſs of its individual members; but that proſperity depends much upon the conduct of its governors. When, therefore, individuals intercede for their governors, the ultimate object of their prayers muſt be conceived to be their own good. As it is equally the duty of all the members of the community to pray for their governors, ſuch interceſſions are the prayers of the whole community for itſelf, and of every individual for himſelf. So that in this view of the caſe, the moſt juſt, we apprehend, that can be taken of it, it is not true that ſupplications and interceſſions for kings and all in authority are the prayers of one individual for another, but the prayers of many individuals for that body of which each of them knows himſelf to be a member. Prayer ‖ Preadamite.

Having evinced the duty of adoration, confeſſion, ſupplication, and interceſſion, we need not ſurely waſte our readers time with a formal and laboured vindication of thankſgiving. Gratitude for benefits received is ſo univerſally acknowledged to be a virtue, and ingratitude is ſo deteſtable a vice, that no man who lays claim to a moral character will dare to affirm that we ought not to have a juſt ſenſe of the goodneſs of God in preſerving us from the numberleſs dangers to which we are expoſed, and "in giving us rain from heaven, and fruitful ſeaſons, filling our hearts with food and gladneſs." But if we have this ſenſe, whether we expreſs it in words or not, we offer to God thankſgiving; becauſe every movement of the heart is open and expoſed to his all-ſeeing eye.

In this article we have treated of prayer in general, and as the private duty of every individual; but there ought to be *public* as well as *private* prayer, which ſhall be conſidered afterwards. (See WORSHIP.) We have likewiſe obſerved, that the prayers of every Chriſtian ought to be offered in the name and through the mediation of Jeſus Chriſt, for which the reaſon will be ſeen in the article THEOLOGY. We ſhall conclude our reflections on the general duty, with obſerving, that nothing ſo forcibly reſtrains from ill as the remembrance of a recent addreſs to heaven for protection and aſſiſtance. After having petitioned for power to reſiſt temptation, there is ſo great an incongruity in not continuing the ſtruggle, that we bluſh at the thought, and perſevere leſt we loſe all reverence for ourſelves. After fervently devoting our ſouls to God, we ſtart with horror at immediate apoſtacy: every act of deliberate wickedneſs is then complicated with hypocriſy and ingratitude: it is a mockery of the Father of Mercies, the forfeiture of that peace in which we cloſed our addreſs, and a renunciation of the hope which that addreſs inſpired. But if prayer and immorality be thus incompatible, ſurely the former ſhould not be neglected by thoſe who contend that moral virtue is the ſummit of human perfection.

PREACHING. See DECLAMATION, Art. I.—The word is derived from the Hebrew *paraſch*, *expoſuit*, "he expounded."

PREADAMITE, a denomination given to the inhabitants of the earth, conceived, by ſome people, to have lived before Adam.

Iſaac de la Pereyra, in 1655, publiſhed a book to evince the reality of Preadamites, by which he gained a conſiderable number of proſelytes to the opinion: but the anſwer of Demarets, profeſſor of theology at Groningen, publiſhed the year following, put a ſtop to its progreſs; though Pereyra made a reply.

His ſyſtem was this: The Jews he calls *Adamites*, and ſuppoſes them to have iſſued from Adam; and gives the title *Preadamites* to the Gentiles, whom he ſuppoſes to have been a long time before Adam. But this being expreſsly contrary to the firſt words of Geneſis, Pereyra had recourſe to the fabulous antiquities of the Egyptians and Chaldeans, and to ſome idle rabbins, who imagined there had been another world before that

Preamble || Precept.

described by Moſes. He was apprehended by the inquiſition in Flanders, and very roughly uſed, though in the ſervice of the dauphin. But he appealed from their ſentence to Rome; whither he went in the time of Alexander VII. and where he printed a retractation of his book of Preadamites. See PRE-EXISTENCE.

PREAMBLE, in law, the beginning of an act of parliament, &c. which ſerves to open the intent of the act, and the miſchiefs intended to be remedied by it.

PREBEND, the maintenance a prebendary receives out of the eſtate of a cathedral or collegiate church. Prebends are diſtinguiſhed into ſimple and dignitary: a ſimple prebend has no more than the revenue for its ſupport; but a prebend with dignity has always a juriſdiction annexed to it.

PREBENDARY, an eccleſiaſtic who enjoys a prebend.

The difference between a prebendary and a canon is, that the former receives his prebend in conſideration of his officiating in the church, but the latter merely by his being received into the cathedral or college.

PRECARIUM, in Scots law. See LAW, N° clxxiii. 9.

PRECEDENCE, a place of honour to which a perſon is entitled. This is either of courteſy or of right. The former is that which is due to age, eſtate, &c. which is regulated by cuſtom and civility: the latter is ſettled by authority; and when broken in upon, gives an action at law.

In Great Britain, the order of precedency is as follows: The king; the princes of the blood; the archbiſhop of Canterbury; the lord high chancellor; the archbiſhop of York; the lord treaſurer of England; the lord preſident of the council; the lord privy ſeal; dukes; the eldeſt ſons of dukes of the blood royal; marquiſſes; dukes eldeſt ſons; earls; marquiſſes eldeſt ſons; dukes younger ſons; viſcounts; earls eldeſt ſons; marquiſſes younger ſons; biſhops; barons; ſpeaker of the houſe of commons; lord commiſſioner of the great ſeal; viſcounts eldeſt ſons; earls younger ſons; barons eldeſt ſons; privy counſellors not peers; chancellor of the exchequer; chancellor of the duchy; knights of the garter not peers; lord chief juſtice of the king's bench; maſter of the rolls; lord chief juſtice of the common pleas; lord chief baron of the exchequer; puiſne judges and barons; knights banneret, if made in the field; maſters in chancery; viſcounts younger ſons; barons younger ſons; baronets; knights banneret; knights of the Bath; knights bachelors; baronets eldeſt ſons; knights eldeſt ſons; baronets younger ſons; knights younger ſons; field and flag officers; doctors graduate; ſerjeants at law; eſquires; gentlemen bearing coat armour; yeomen; tradeſmen; artificers; labourers.—*Note*, The ladies, except thoſe of archbiſhops, biſhops, and judges, take place according to the degree of quality of their huſbands; and unmarried ladies take place according to that of their fathers.

PRECEDENT, in law, a caſe which has been determined, and which ſerves as a rule for all of the ſame nature.

PRECENTOR, a dignity in cathedrals, popularly called the *chantor*, or *maſter of the choir*.

PRECEPT, in law, a command in writing ſent by a chief juſtice or juſtice of the peace, for bringing a perſon, record, or other matter before him.

PRECEPT of Clare Conſtat, in Scots law. See LAW, Part III. n° clxxx. 28.

PRECEPT of Seiſin, in Scots law. See LAW, Part III. n° clxiv. 16.

Precept || Proceſſion.

PRECEPTIVE, any thing which gives or contains precepts.

PRECEPTIVE Poetry. See POETRY, n° 146, &c.

PRECESSION OF THE EQUINOXES. The moſt obvious of all the celeſtial motions is the diurnal revolution of the ſtarry heavens. The whole appears to turn round an imaginary AXIS, which paſſes through two oppoſite points of the heavens, called the *poles*. One of theſe is in our ſight, being very near the ſtar and in the tail of the little bear. The great circle which is equidiſtant from both poles divides the heavens into the northern and ſouthern hemiſpheres, which are equal. It is called the *equator*, and it cuts the horizon in the eaſt and weſt points, and every ſtar in it is 12 ſiderial hours above and as many below the horizon, in each revolution.

1 Diurnal revolution of the ſtarry heavens.

2 Obſervations of the Aſiatic ſhepherds.

The ſun's motions determine the length of day and night, and the viciſſitudes of the ſeaſons. By a long ſeries of obſervations, the ſhepherds of Aſia were able to mark out the ſun's path in the heavens; he being always in the oppoſite point to that which comes to the meridian at midnight, with equal but oppoſite declination. Thus they could tell the ſtars among which the ſun then was, although they could not ſee them. They diſcovered that his path was a great circle of the heavens, afterward called the ECLIPTIC; which cuts the Equator in two oppoſite points, dividing it, and being divided by it, into two equal parts. They farther obſerved, that when the ſun was in either of theſe points of interſection, his circle of diurnal revolution coincided with the equator, and therefore the days and nights were equal. Hence the equator came to be called the EQUINOCTIAL LINE, and the points in which it cuts the ecliptic were called the EQUINOCTIAL POINTS, and the ſun was then ſaid to be in the equinoxes. One of theſe was called the VERNAL and the other the AUTUMNAL EQUINOX.

3 To determine the time of the ſun's occupying the equinoctial points.

It was evidently an important problem in practical aſtronomy to determine the exact moment of the ſun's occupying theſe ſtations; for it was natural to compute the courſe of the year from that moment. Accordingly this has been the leading problem in the aſtronomy of all nations. It is ſuſceptible of conſiderable preciſion, without any apparatus of inſtruments. It is only neceſſary to obſerve the ſun's declination on the noon of two or three days before and after the equinoctial day. On two conſecutive days of this number, his declination muſt have changed from north to ſouth, or from ſouth to north. If his declination on one day was obſerved to be 21′ north, and on the next 5′ ſouth, it follows that his declination was nothing, or that he was in the equinoctial point about 23 minutes after 7 in the morning of the ſecond day. Knowing the preciſe moments, and knowing the rate of the ſun's motion in the ecliptic, it is eaſy to aſcertain the preciſe point of the ecliptic in which the equator interſected it.

4 Hipparchus's diſcoveries.

By a ſeries of ſuch obſervations made at Alexandria between the years 161 and 127 before Chriſt, Hipparchus the father of our aſtronomy found that the point of the autumnal equinox was about ſix degrees to the eaſtward of the ſtar called SPICA VIRGINIS. Eager to determine

Preceſſion. determine everything by multiplied obſervations, he ranſacked all the Chaldean, Egyptian, and other records, to which his travels could procure him acceſs, for obſervations of the ſame kind; but he does not mention his having found any. He found, however, ſome obſervations of Ariſtillus and Timochares made about 150 years before. From theſe it appeared evident that the point of the autumnal equinox was then about eight degrees eaſt of the ſame ſtar. He diſcuſſes theſe obſervations with great ſagacity and rigour; and, on their authority, he aſſerts that the equinoctial points are not fixed in the heavens, but move to the weſtward about a degree in 75 years or ſomewhat leſs.

5 Why called the preceſſion of the equinoxes. This motion is called the PRECESSION OF THE EQUINOXES, becauſe by it the time and place of the ſun's equinoctial ſtation precedes the uſual calculations: it is fully confirmed by all ſubſequent obſervations. In 1750 the autumnal equinox was obſerved to be 20° 21′ weſtward of ſpica virginis. Suppoſing the motion to have been uniform during this period of ages, it follows that the annual preceſſion is about $50''\frac{1}{3}$; that is, if the celeſtial equator cuts the ecliptic in a particular point on any day of this year, it will on the ſame day of the following year cut it in a point $50''\frac{1}{3}$ to the weſt of it, and the ſun will come to the equinox 20′ 23″ before he has completed his round of the heavens. Thus the equinoctial or tropical year, or true year of ſeaſons, is ſo much ſhorter than the revolution of the ſun or the ſidereal year.

6 Importance of the diſcovery. It is this diſcovery that has chiefly immortalized the name of Hipparchus, though it muſt be acknowledged that all his aſtronomical reſearches have been conducted with the ſame ſagacity and intelligence. It was natural therefore for him to value himſelf highly for the diſcovery. It muſt be acknowledged to be one of the moſt ſingular that has been made, that the revolution of the whole heavens ſhould not be ſtable, but its axis continually changing. For it muſt be obſerved, that ſince the equator changes its poſition, and the equator is only an imaginary circle, equidiſtant from the two poles or extremities of the axis; theſe poles and this axis muſt equally change their poſitions. The equinoctial points make a complete revolution in about 25745, the equator being all the while inclined to the ecliptic in nearly the ſame angle. Therefore the poles of this diurnal revolution muſt deſcribe a circle round the poles of the ecliptic at the diſtance of about $23\frac{1}{2}$ degrees in 25745 years; and in the time of Timochares the north pole of the heavens muſt have been 30 degrees eaſtward of where it now is.

7 Hipparchus has been accuſed of plagiariſm, Hipparchus has been accuſed of plagiariſm and inſincerity in this matter. It is now very certain that the preceſſion of the equinoxes was known to the aſtronomers of India many ages before the time of Hipparchus. It appears alſo that the Chaldeans had a pretty accurate knowledge of the year of ſeaſons. From their ſaros we deduce their meaſure of this year to be 365 days 5 hours 49 minutes and 11 ſeconds, exceeding the truth only by 26″, and much more exact than the year of Hipparchus. They had alſo a ſidereal year of 365 days 6 hours 11 minutes. Now what could occaſion an attention to two years, if they did not ſuppoſe the equinoxes moveable? The Egyptians alſo had a knowledge of ſomething equivalent to this: for they had diſcovered that the dog-ſtar was no longer the faithful forwarner of the overflowing of the Nile; and they combined him with the ſtar Fomalhaſet* in their myſtical kalendar. This knowledge is alſo involved in the precepts of the Chineſe aſtronomy, of much older date than the time of Hipparchus.

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* See Dupins ſur le zodiaque des Egyptiens, *Mem. de l'Acad. des Inſcrip.* 8

But falſely.

But all theſe acknowledged facts are not ſufficient for depriving Hipparchus of the honour of the diſcovery, or fixing on him the charge of plagiariſm. This motion was a thing unknown to the aſtronomers of the Alexandrian ſchool, and it was pointed out to them by Hipparchus in the way in which he aſcertained every other poſition in aſtronomy, namely, as the mathematical reſult of actual obſervations, and not as a thing deducible from any opinions on other ſubjects related to it. We ſee him, on all other occaſions, eager to confirm his own obſervations, and his deductions from them, by every thing he could pick up from other aſtronomers; and he even adduced the above-mentioned practice of the Egyptians in corroboration of his doctrine. It is more than probable then that he did not know any thing more. Had he known the Indian preceſſion of 54″ annually, he had no temptation whatever to withhold him from uſing it in preference to one which he acknowledges to be inaccurate, becauſe deduced from the very ſhort period of 150 years, and from the obſervations of Timochares, in which he had no great confidence.

9 Heavenly motions accounted for by the Copernican ſyſtem, This motion of the ſtarry heavens was long a matter of diſcuſſion, as a thing for which no phyſical reaſon could be aſſigned. But the eſtabliſhment of the Copernican ſyſtem reduced it to a very ſimple affair; the motion which was thought to affect all the heavenly bodies, is now acknowledged to be a deception, or a falſe judgment from the appearances. The earth turns round its own axis while it revolves round the ſun, in the ſame manner as we may cauſe a child's top to ſpin on the brim of a mill-ſtone, while the ſtone is turning ſlowly round its axis. If the top ſpin ſteadily, without any wavering, its axis will always point to the zenith of the heavens; but we frequently ſee, that while it ſpins briſkly round its axis, the axis itſelf has a ſlow conical motion round the vertical line, ſo that, if produced, it would ſlowly deſcribe a circle in the heavens round the zenith point. The flat ſurface of the top may repreſent the terreſtrial equator, gradually turning itſelf round on all ſides. If this top were formed like a ball, with an equatorial circle on it, it would repreſent the whole motion very prettily, the only difference being, that the ſpinning motion and this wavering motion are in the ſame direction; whereas the diurnal rotation and the motion of the equinoctial points are in contrary directions. Even this diſſimilarity may be removed, by making the top turn on a cap, like the card of a mariner's compaſs.

10 And the earth's. It is now a matter fully eſtabliſhed, that while the earth revolves round the ſun from weſt to eaſt, in the plane of the ecliptic, in the courſe of a year it turns round its own axis from weſt to eaſt in $23^h\ 56'\ 4''$, which axis is inclined to this plane in an angle of nearly 23° 28′; and that this axis turns round a line perpendicular to the ecliptic in 25,745 years from eaſt to weſt, keeping nearly the ſame inclination to the ecliptic.—By this means, its pole in the ſphere of the ſtarry heavens deſcribes a circle round the pole of the ecliptic at the diſtance of 23° 28′ nearly. The conſequence of this muſt be, that the terreſtrial equator, when produ-

Precession. ced to the sphere of the starry heavens, will cut the ecliptic in two opposite points, through which the sun must pass when he makes the day and night equal; and that these points must shift to the westward, at the rate of 50¼ seconds annually, which is the precession of the equinoxes. Accordingly this has been the received doctrine among astronomers for nearly three centuries, and it was thought perfectly conformable to appearances.

11 Bradley's attempt to discover the parallax of the earth's orbit.

But Dr Bradley, the most sagacious of modern astronomers, hoped to discover the parallax of the earth's orbit by observations of the actual position of the pole of the celestial revolution. Dr Hooke had attempted this before, but with very imperfect instruments. The art of observing being now prodigiously improved, Dr Bradley resumed this investigation. It will easily appear, that if the earth's axis keeps parallel to itself, its extremity must describe in the sphere of the starry heavens a figure equal and parallel to its orbit round the sun; and if the stars be so near that this figure is a visible object, the pole of diurnal revolution will be in different distinguishable points of this figure. Consequently, if the axis describes the cone already mentioned, the pole will not describe a circle round the pole of the ecliptic, but will have a looped motion along this circumference, similar to the absolute motion of one of Jupiter's satellites, describing an epicycle whose centre describes the circle round the pole of the ecliptic.

12 Difficulties in the attempt obviated by accident.

He accordingly observed such an epicyclical motion, and thought that he had now overcome the only difficulty in the Copernican system; but, on maturely considering his observations, he found this epicycle to be quite inconsistent with the consequences of the annual parallax, and it puzzled him exceedingly. One day, while taking the amusement of sailing about on the Thames, he observed, that every time the boat tacked, the direction of the wind, estimated by the direction of the vane, seemed to change. This immediately suggested to him the cause of his observed epicycle, and he found it an optical illusion, occasioned by a combination of the motion of light with the motion of his telescope while observing the polar stars. Thus he unwittingly established an incontrovertible argument for the truth of the Copernican system, and immortalized his name by his discovery of the ABERRATION of the stars.

13 His further investigation of the subject.

He now engaged in a series of observations for ascertaining all the circumstances of this discovery. In the course of these, which were continued for 28 years, he discovered another epicyclical motion of the pole of the heavens, which was equally curious and unexpected. He found that the pole described an epicycle, whose diameter was about 18″, having for its centre that point of the circle round the pole of the ecliptic in which the pole would have been found independent of this new motion. He also observed, that the period of this epicyclical motion was 18 years and seven months. It struck him, that this was precisely the period of the revolution of the nodes of the moon's orbit. He gave a brief account of these results to Lord Macclesfield, then president of the Royal Society, in 1747. Mr Machin, to whom he also communicated the observations, gave him in return a very neat mathematical hypothesis, by which the motion might be calculated.

Plate CCCCXIV Let E (fig. 1.), be the pole of the ecliptic, and SPQ a circle distant from it 23° 28′, representing the circle described by the pole of the equator during one revolution of the equinoctial points. Let P be the place of this last mentioned pole at some given time. Round P describe a circle ABCD, whose diameter AC is 18′. The real situation of the pole will be in the circumference of this circle; and its place, in this circumference, depends on the place of the moon's ascending node. Draw EPF and GPL perpendicular to it; let GL be the colure of the equinoxes, and EF the colure of the solstices. Dr Bradley's observations showed that the pole was in A when the node was in L, the vernal equinox. If the node recede to H, the winter solstice, the pole is in B. When the node is in the autumnal equinox at G, the pole is at C; and when the node is in F, the summer solstice, the pole is in D. In all intermediate situations of the moon's ascending node, the pole is in a point of the circumference ABCD, three signs or 90° more advanced.

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14 Mathematical theory if the poles of the equator be supposed to describe a circle.

15 More exact if an ellipse be substituted for the circle.

Dr Bradley, by comparing together a great number of observations, found that the mathematical theory, and the calculation depending on it, would correspond much better with the observations, if an ellipse were substituted for the circle ABCD, making the longer axis AC 18″, and the shorter, BD, 16″. Mr d'Alembert determined, by the physical theory of gravitation, the axes to be 18″ and 13″,4.

16 These observations and this theory are facts in astronomy.

These observations, and this mathematical theory, must be considered as so many facts in astronomy, and we must deduce from them the methods of computing the places of all celestial phenomena, agreeable to the universal practice of determining every point of the heavens by its longitude, latitude, right ascension, and declination.

17 Obliquity of the ecliptic.

It is evident, in the first place, that this equation of the pole's motion makes a change in the obliquity of the ecliptic. The inclination of the equator to the ecliptic is measured by the arch of a great circle intercepted between their poles. Now, if the pole be in O instead of P, it is plain that the obliquity is measured by EO instead of EP. If EP be considered as the mean obliquity of the ecliptic, it is augmented by 9″ when the moon's ascending node is in the vernal equinox, and consequently the pole in A. It is, on the contrary, diminished 9″ when the node is in the autumnal equinox, and the pole in C; and it is equal to the mean when the node is in the colure of the solstices. This change of the inclination of the earth's axis to the plane of the ecliptic was called the NUTATION of the axis by Sir Isaac Newton; who showed, that a change of nearly a second must obtain in a year by the action of the sun on the prominent parts of the terrestrial spheroid. But he did not attend to the change which would be made in this motion by the variation which obtains in the disturbing force of the MOON, in consequence of the different obliquity of her action on the equator, arising from the motion of her own oblique orbit. It is this change which now goes by the name NUTATION, and we owe its discovery entirely to Dr Bradley. The general change of the position of the earth's axis has been termed DEVIATION by modern astronomers.

18 Quantity of it easily ascertained.

The quantity of this change of obliquity is easily ascertained. It is evident, from what has been already said, that when the pole is in O, the arch ADCO is equal

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19 Change of the equinoctial points. But the nutation changes alſo the longitudes and right aſcenſions of the ſtars and planets by changing the equinoctial points, and thus occaſioning an equation in the preceſſion of the equinoctial points. It was this circumſtance which made it neceſſary for us to conſider it in this place, while expreſsly treating of this preceſſion. Let us attend to this derangement of the equinoctial points.

20 Situation of the ſolſtitial and equinoctial colures. The great circle or meridian which paſſes through the poles of the ecliptic and equator is always the ſolſtitial colure, and the equinoctial colure is at right angles to it: therefore when the pole is in P or in O, EP or EO is the ſolſtitial colure. Let S be any fixed ſtar or planet, and let SE be a meridian or circle of longitude; draw the circles of declination PS, OS, and the circles M′EM′, mEm', perpendicular to PE, OE.

21 Equation of longitude from nutation of the earth's axis. If the pole were in its mean place P, the equinoctial points would be in the ecliptic meridian M′EM′, or that meridian would paſs through the interſections of the equator and ecliptic, and the angle M′ES would meaſure the longitude of the ſtar S. But when the pole is in O, the ecliptic meridian mEm' will paſs thro' the equinoctial points. The equinoctial points muſt therefore be to the weſtward of their mean place, and the equation of the preceſſion muſt be additive to that preceſſion; and the longitude of the ſtar S will now be meaſured by the angle mES, which, in the caſe here repreſented, is greater than its mean longitude. The difference, or the equation of longitude, ariſing from the nutation of the earth's axis, is the angle OEP, or $\frac{OM}{OE}$. OM is the ſine of the angle CPO, which, by what has been already obſerved, is equal to the longitude of the node: Therefore OM is equal to $9'' \times$ long. node, and $\frac{OM}{OE}$ is equal to $\frac{9'' \times \text{ſin. long. node}}{\text{ſin. obliq}^{y}. \text{ eclip.}}$. This equation is additive to the mean longitude of the ſtar when O is in the ſemicircle CBA, or while the aſcending node is paſſing backwards from the vernal to the autumnal equinox; but it is ſubtractive from it while O is in the ſemicircle ADC, or while the node is paſſing backwards from the autumnal to the vernal equinox; or, to expreſs it more briefly, the equation is ſubtractive from the mean longitude of the ſtar, while the aſcending node is in the firſt ſix ſigns, and additive to it while the node is in the laſt ſix ſigns.

This equation of longitude is the ſame for all the ſtars, for their longitude is reckoned on the ecliptic (which is here ſuppoſed invariable); and therefore is affected only by the variation of the point from which the longitude is computed.

22 Right aſcenſion ſuffers a double change. The right aſcenſion, being computed on the equator, ſuffers a double change. It is computed from, or begins at, a different point of the equator, and it terminates at a different; point becauſe the equator having changed its poſition, the circles of declination alſo change theirs. When the pole is at P, the right aſcenſion of S from the ſolſtitial colure is meaſured by the angle SPE, contained between that colure and the ſtar's circle of declination. But when the pole is at O, the right aſcenſion is meaſured by the angle SOE, and the difference of SPE and SOE is the equation of right aſcenſion. The angle SOE conſiſts of two parts, GOE and GOS; GOE remains the ſame wherever the ſtar S is placed, but GOS varies with the place of the ſtar.—We muſt firſt find the variation by which GPE becomes GOE, which variation is common to all the ſtars. The triangles GPE, GOE, have a conſtant ſide GE, and a conſtant angle G; the variation PO of the ſide GP is extremely ſmall, and therefore the variation of the angles may be computed by Mr Cotes's Fluxionary Theorems. See Simpſon's *Fluxions*, § 253, &c. As the tangent of the ſide EP, oppoſite to the conſtant angle G, is to the ſine of the angle EPG, oppoſite to the conſtant ſide EG, ſo is PO the variation of the ſide GP, adjacent to the conſtant angle, to the variation x of the angle GPO, oppoſite to the conſtant ſide EG. This gives $x = \frac{9'' \times \text{ſin. long. node}}{\text{tang. obl. eclip.}}$. This is ſubtractive from the mean right aſcenſion for the firſt ſix ſigns of the node's longitude, and additive for the laſt ſix ſigns. This equation is common to all the ſtars.

23 Other variations, &c. The variation of the other part SOG of the angle, which depends on the different poſition of the hour circles PS and OS, which cauſes them to cut the equation in different points, where the arches of right aſcenſion terminate, may be diſcovered as follows. The triangles SPG, SOG, have a conſtant ſide SG, and a conſtant angle G. Therefore, by the ſame Coteſian theorem, tan. SP : ſin. SPG = PO : y, and y, or the ſecond part of the nutation in right aſcenſion, $= \frac{9'' \times \text{ſin. diff. R. A. of ſtar and node}}{\text{cotan. declin. ſtar}}$.

24 Nutation affects the declinations of the ſtars. The nutation alſo affects the declination of the ſtars: For SP, the mean codeclination, is changed into SO.—Suppoſe a circle deſcribed round S, with the diſtance SO cutting SP in f; then it is evident that the equation of declin. is $Pf = PO \times$ coſine $OPf = 9'' \times$ ſign r. aſcen. of ſtar—long. of node.

25 A more exact mode of calculation. Such are the calculations in conſtant uſe in our aſtronomical reſearches, founded on Machin's Theory. When ſtill greater accuracy is required, the elliptical theory muſt be ſubſtituted, by taking (as is expreſſed by the dotted lines) O in that point of the ellipſe deſcribed on the tranſverſe axis AC, where it is cut by OM, drawn according to Machin's theory. All the change made here is the diminution of OM in the ratio of 18 to 13,4, and a correſponding diminution of the angle CPO. The detail of it may be ſeen in De la Lande's *Aſtronomy*, art. 2874; but is rather foreign to our preſent purpoſe of explaining the preceſſion of the equinoxes. The calculations being in every caſe tedious, and liable to miſtakes, on account of the changes of the ſigns of the different equations, the zealous promoters of aſtronomy have calculated and publiſhed tables of all theſe equations, both on the circular and elliptical hypotheſis. And ſtill more to abridge calculations, which occur in reducing every aſtronomical obſervation, when the place of a phenomenon is deduced from a compari-

ſon

Preceſſion. ſon with known fixed ſtars, there have been publiſhed tables of nutation and preceſſion, for ſome hundreds of the principal ſtars, for every poſition of the moon's node and of the ſun.

26 Preceſſion of the equinoctial points, &c. It now remains to conſider the preceſſion of the equinoctial points, with its equations, ariſing from the nutation of the earth's axis as a phyſical phenomenon, and to endeavour to account for it upon thoſe mechanical principles which have ſo happily explained all the other phenomena of the celeſtial motions.

27 Obſervations of Newton and others on this ſubject. This did not eſcape the penetrating eye of Sir Iſaac Newton; and he quickly found it to be a conſequence, and the moſt beautiful proof, of the univerſal gravitation of all matter to all matter; and there is no part of his immortal work where his ſagacity and fertility of reſource ſhine more conſpicuouſly than in this inveſtigation. It muſt be acknowledged, however, that Newton's inveſtigation is only a ſhrewd gueſs, founded on aſſumptions, of which it would be extremely difficult to demonſtrate either the truth or falſity, and which required the genius of a Newton to pick out in ſuch a complication of abſtruſe circumſtances. The ſubject has occupied the attention of the firſt mathematicians of Europe ſince his time; and is ſtill conſidered as the moſt curious and difficult of all mechanical problems. The moſt elaborate and accurate diſſertations on the preceſſion of the equinoxes are thoſe of Sylvabella and Walmeſly, in the Philoſophical Tranſactions, publiſhed about the year 1754; that of Thomas Simpſon, publiſhed in his Miſcellaneous Tracts; that of Father Friſius, in the Memoirs of the Berlin Academy, and afterwards, with great improvements, in his Coſmographia; that of Euler in the Memoirs of Berlin; that of D'Alembert in a ſeparate diſſertation; and that of De la Grange on the Libration of the Moon, which obtained the prize in the Academy of Paris in 1769. We think the diſſertation of Father Friſius the moſt perſpicuous of them all, being conducted in the method of geometrical analyſis; whereas moſt of the others proceed in the fluxionary and ſymbolic method, which is frequently deficient in diſtinct notions of the quantities under conſideration, and therefore does not give us the ſame perſpicuous conviction of the truth of the reſults. In a work like ours, it is impoſſible to do juſtice to the problem, without entering into a detail which would be thought extremely diſproportioned to the ſubject by the generality of our readers. Yet thoſe who have the neceſſary preparation of mathematical knowledge, and wiſh to underſtand the ſubject fully, will find enough here to give them a very diſtinct notion of it; and in the article Rotation, they will find the fundamental theorems, which will enable them to carry on the inveſtigation. We ſhall firſt give a ſhort ſketch of Newton's inveſtigation, which is of the moſt palpable and popular kind, and is highly valuable, not only for its ingenuity, but alſo becauſe it will give our unlearned readers diſtinct and ſatisfactory conceptions of the chief circumſtances of the whole phenomena.

28 Sketch of Newton's inveſtigation of it. Let S (fig. 2.) be the ſun, E the Earth, and M the Moon, moving in the orbit NMCD*n*, which cuts the plane of the Ecliptic in the line of the nodes N*n*, and has one half raiſed above it, as repreſented in the figure, the other half being hid below the Ecliptic. Suppoſe this orbit folded down; it will coincide with the Ecliptic in the circle N *m c d n*. Let EX repreſent the

Plate CCCCXIV

axis of this orbit, perpendicular to its plane, and therefore inclined to the Ecliptic. Since the Moon gravitates to the ſun in the direction MS, which is all above the Ecliptic, it is plain that this gravitation has a tendency to draw the Moon towards the Ecliptic. Suppoſe this force to be ſuch that it would draw the Moon down from M to *i* in the time that ſhe would have moved from M to *t*, in the tangent to her orbit. By the combination of theſe motions, the Moon will deſert her orbit, and deſcribe the line M*r*, which makes the diagonal of the parallelogram; and if no farther action of the ſun be ſuppoſed, ſhe will deſcribe another orbit M*δn'*, lying between the orbit MCD*n* and the Ecliptic, and ſhe will come to the Ecliptic, and paſs through it in a point *n'*, nearer to M than *n* is, which was the former place of her deſcending node. By this change of orbit, the line EX will no longer be perpendicular to it; but there will be another line E*x*, which will now be perpendicular to the new orbit. Alſo the Moon, moving from M to *r*, does not move as if ſhe had come from the aſcending node N, but from a point N lying beyond it; and the line of the nodes of the orbit in this new poſition is N' *n'*. Alſo the angle MN'*m* is leſs than the angle MN*m*.

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Thus the nodes ſhift their places in a direction oppoſite to that of her motion, or move to the weſtward; the axis of the orbit changes its poſition, and the orbit itſelf changes its inclination to the ecliptic. Theſe momentary changes are different in different parts of the orbit, according to the poſition of the line of the nodes. Sometimes the inclination of the orbit is increaſed, and ſometimes the nodes move to the eaſtward. But, in general, the inclination increaſes from the time that the nodes are in the line of ſyzigee, till they get into quadrature, after which it diminiſhes till the nodes are again in ſyzigee. The nodes advance only while they are in the octants after the quadratures, and while the moon paſſes from quadrature to the node, and they recede in all other ſituations. Therefore the receſs exceeds the advance in every revolution of the moon round the earth, and, on the whole, they recede.

What has been ſaid of one Moon, would be true of each of a continued ring of Moons ſurrounding the Earth, and they would thus compoſe a flexible ring, which would never be flat, but waved, according to the difference (both in kind and degree) of the diſturbing forces acting on its different parts. But ſuppoſe theſe Moons to cohere, and to form a rigid and flat ring, nothing would remain in this ring but the exceſs of the contrary tendencies of its different parts. Its axis would be perpendicular to its plane, and its poſition in any moment will be the mean poſition of all the axes of the orbits of each part of the flexible ring; therefore the nodes of this rigid ring will continually recede, except when the plane of the ring paſſes through the Sun, that is, when the nodes are in ſyzigee; and (ſays Newton) the motion of theſe nodes will be the ſame with the mean motion of the nodes of the orbit of one Moon. The inclination of this ring to the ecliptic will be equal to the mean inclination of the Moon's orbit during any one revolution which has the ſame ſituation of the nodes. It will therefore be leaſt of all when the nodes are in quadrature, and will increaſe till they are in ſyzigee, and then diminiſh till they are again in quadrature.

Suppoſe this ring to contract in dimenſions, the diſ-

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Now there is ſuch a ring on the earth: for the earth is not a ſphere, but an elliptical ſpheroid. Sir Iſaac Newton therefore engaged in a computation of the effects of the diſturbing force, and has exhibited a moſt beautiful example of mathematical inveſtigation He firſt aſſerts, that the earth *muſt* be an elliptical ſpheroid, whoſe polar axis is to its equatorial diameter as 229 to 230. Then he demonſtrates, that if the ſine of the inclination of the equator be called π, and if t be the number of days (ſidereal) in a year, the annual motion of a detached ring will be $360^\circ \times \frac{3\sqrt{1-\pi^2}}{4t}$. He then ſhows that the effect of the diſturbing force on this ring is to its effect on the matter of the ſame ring, diſtributed in the form of an elliptical ſtratum (but ſtill detached) as 5 to 2; therefore the motion of the nodes will be $360^\circ \times \frac{3\sqrt{1-\pi^2}}{10t}$, or 16′ 16″ 24‴ annually. He then proceeds to ſhow, that the quantity of motion in the ſphere is to that in an equatorial ring revolving in the ſame time, as the matter in the ſphere to the matter in the ring, and as three times the ſquare of a quadrantal arch to two ſquares of a diameter, jointly: Then he ſhows, that the quantity of matter in the terreſtrial ſphere is to that in the protuberant matter of the ſpheroid, as 52900 to 461 (ſuppoſing all homogeneous). From theſe premiſes it follows, that the motion of 16′ 16″ 24‴, muſt be diminiſhed in the ratio of 10717 to 100, which reduces it to 9″ 07‴ annually. And this (he ſays) is the preceſſion of the equinoxes, occaſioned by the action of the ſun; and the reſt of the $50\frac{1}{3}''$, which is the obſerved preceſſion, is owing to the action of the moon, nearly five times greater than that of the ſun. This appeared a great difficulty: for the phenomena of the tides ſhow that it *cannot* much exceed twice the ſun's force.

29 His determination of the form and dimenſions of the earth demonſtrated by M'Laurin.

Nothing can exceed the ingenuity of this proceſs. Juſtly does his celebrated and candid commentator, Daniel Bernoulli, ſay (in his Diſſertation on the Tides, which ſhared the prize of the French Academy with M'Laurin and Euler), that Newton ſaw through a veil what others could hardly diſcover with a microſcope in the light of the meridian ſun. His determination of the form and dimenſions of the earth, which is the foundation of the whole proceſs, is not offered as any thing better than a probable gueſs, *in re difficillima*; and it has been ſince demonſtrated with geometrical rigour by M'Laurin. Preceſſion.

His next principle, that the motion of the nodes of the rigid ring is equal to the mean motion of the nodes of the moon, has been moſt critically diſcuſſed by the firſt mathematicians, as a thing which could neither be proved nor refuted. Friſius has at leaſt ſhown it to be a miſtake, and that the motion of the nodes of the ring is double the mean motion of the nodes of a ſingle moon; and that Newton's own principles ſhould have produced a preceſſion of $18\frac{1}{4}$ ſeconds annually, which removes the difficulty formerly mentioned.

His third aſſumption, that the quantity of motion of the ring muſt be ſhared with the included ſphere, was acquieſced in by all his commentators, till D'Alembert and Euler, in 1749, ſhowed that it was not the quantity of motion round an axis of rotation which remained the ſame, but the quantity of momentum or rotatory effort. The quantity of motion is the product of every particle by its velocity; that is, by its diſtance from the axis; while its momentum, or power of producing rotation, is as the ſquare of that diſtance, and is to be had by taking the ſum of each particle multiplied by the ſquare of its diſtance from the axis. Since the earth differs ſo little from a perfect ſphere, this makes no ſenſible difference in the reſult. It will increaſe Newton's preceſſion about three-fourths of a ſecond.

30 Examination of the phenomenon of preceſſion on mechanical principles.

We proceed now to the examination of this phenomenon upon the fundamental principles of mechanics.

Becauſe the mutual gravitation of the particles of matter in the ſolar ſyſtem is in the inverſe ratio of the ſquares of the diſtance, it follows, that the gravitations of the different parts of the earth to the ſun or to the moon are unequal. The nearer particles gravitate more than thoſe that are more remote.

Let PQpE (fig. 3.), be a meridional ſection of the terreſtrial ſphere, and POpq the ſection of the inſcribed ſphere. Let CS be a line in the plane of the ecliptic paſſing through the ſun, ſo that the angle ECS is the ſun's declination. Let NCM be a plane paſſing thro' the centre of the earth at right angles to the plane of the meridian PQpE; NCM will therefore be the plane of illumination. Plate CCCXIV

In conſequence of the unequal gravitation of the matter of the earth to the ſun, every particle, ſuch as B, is acted on by a diſturbing force parallel to CS, and proportional to BD, the diſtance of the particle from the plane of illumination; and this force is to the gravitation of the central particle to the ſun, as three times BD is to CS, the diſtance of the earth from the ſun.

Let ABa be a plane paſſing through the particle B, parallel to the plane EQ of the equator. This ſection of the earthwill be a circle, of which Aa is a diameter, and Qq will be the diameter of its ſection with the inſcribed ſphere. Theſe will be two concentric circles, and the ring by which the ſection of the ſpheroid exceeds the ſection of the ſphere will have AQ for its breadth; Pp is the axis of figure.

Let

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Let EC be represented by the symbol - a
OC or PC - - - b
EO their difference, $= \frac{a^2-b^2}{a+b}$ - d
CL - - - x
QL - - - $\sqrt{b^2-x^2}$
The periphery of a circle to radius 1 - π
The disturbing force at the distance 1 from the plane NCM - - f
The sine of declination ECS - m
The cosine of ECS - - n

It is evident, that with respect to the inscribed sphere, the disturbing forces are completely compensated, for every particle has a corresponding particle in the adjoining quadrant, which is acted on by an equal and opposite force. But this is not the case with the protuberant matter which makes up the spheroid. The segments NS*sn* and MT*tm* are more acted on than the segments NT*tn* and MS*sm*; and thus there is produced a tendency to a conversion of the whole earth, round an axis passing through the centre C, perpendicular to the plane PQ*p*E. We shall distinguish this motion from all others to which the spheroid may be subject, by the name LIBRATION. The axis of this libration is always perpendicular to that diameter of the equator over which the sun is, or to that meridian in which he is.

PROB. I. To determine the momentum of libration corresponding to any position of the earth respecting the sun, that is, to determine the accumulated energy of the disturbing forces on all the protuberant matter of the spheroid.

Let B and *b* be two particles in the ring formed by the revolution of AQ, and so situated, that they are at equal distances from the plane NM; but on opposite sides of it. Draw BD, *bd*, perpendicular to NM, and FLG perpendicular to LT.

Then, because the momentum, or power of producing rotation, is as the force and as the distance of its line of direction from the axis of rotation, jointly, the combined momentum of the particles B and *b* will be $f.BD.DC - f.bd.dc$, (for the particles B and *b*, are urged in contrary directions). But the momentum of B is $f.BF.DC + f.FD.DC$, and that of *b* is $f.bG.dC - f.dG.dC$; and the combined momentum is $f.BF.Dd - f.FD.DC + dC, = 2f.BF.LF - 2f.LT.TC$.

Because *m* and *n* are the sine and cosine of the angle ECS or LCT, we have $LT = m.CL$, and $CT = n.CL$, and $LF = m.BL$, and $BF = n.BL$. This gives the momentum $= 2fmn\sqrt{BL^2 - CL^2}$.

The breadth AQ of the protuberant ring being very small, we may suppose, without any sensible error, that all the matter of the line AQ is collected in the point Q; and, in like manner, that the matter of the whole ring is collected in the circumference of its inner circle, and that B and *b* now represent, not single particles, but the collected matter of lines such as AQ, which terminate at B and *b*. The combined momentum of two such lines will therefore be $2mnf.AQ.\sqrt{BL^2 - CL^2}$.

Let the circumference of each parallel of latitude be divided into a great number of indefinitely small and equal parts. The number of such parts in the circumference, of which Q*q* is the diameter, will be $\pi.QL$. To each pair of these there belongs a momentum $2mnf.AQ.\sqrt{BL^2 - CL^2}$. The sum of all the squares of BL, which can be taken round the circle, is one half of as many squares of the radius CL: for BL is the sine of an arch, and the sum of its square and the square of its corresponding cosine is equal to the square of the radius. Therefore the sum of all the squares of the sines, together with the sum of all the squares of the cosines, is equal to the sum of the same number of squares of the radius; and the sum of the squares of the sines is equal to the sum of the squares of the corresponding cosines: therefore the sum of the squares of the radius is double of either sum. Therefore $\int \pi.QL.BL^2 = \frac{1}{2}\pi.QL.QL^2$. In like manner the sum of the number $\pi.QL$ of CL^2s will be $= \pi.QL.CL^2$. These sums, taken for the semicircle, are $\frac{1}{4}\pi.QL.QL^2$, and $\frac{1}{4}\pi.QL.CL^2$, or $\pi.QL.\frac{1}{4}QL^2$, and $\pi.QL.\frac{1}{4}CL^2$: therefore the momentum of the whole ring will be $2mnf.AQ.QL.\pi(\frac{1}{4}QL^2 - \frac{1}{4}CL^2)$: for the momentum of the ring is the combined momenta of a number of pairs, and this number is $\frac{1}{2}\pi.QL$.

By the ellipse we have $OC : QL = EO : AQ$, and $AQ = QL\frac{EO}{OC}, = QL\frac{d}{b}$; therefore the momentum of the ring is $2mnf\frac{d}{b}QL^2\pi\ (\frac{1}{4}QL^2 - \frac{1}{2}CL^2), = mnf\frac{d}{b}QL^2\pi\ (\frac{1}{4}QL^2 - CL^2)$: but $QL^2 = b^2 - x^2$; therefore $\frac{1}{4}QL^2 - CL^2 = \frac{1}{4}b^2 - \frac{1}{4}x^2 - x^2, = \frac{1}{4}b^2 - \frac{3}{4}x^2, = \frac{b^2 - 3x^2}{2}$; therefore the momentum of the ring is $mnf\frac{d}{b}\pi(b^2 - x^2)\left(\frac{b^2 - 3x^2}{2}\right) = mnf\frac{d}{b}\pi\left(\frac{b^4 - 4b^2x^2 + 3x^4}{2}\right), = mnf\frac{d}{2b}\pi\ (b^4 - 4b^2x^2 + 3x^4)$. If we now suppose another parallel extremely near to A *a*, as represented by the dotted line, the distance L *l* between them being $\dot{x}$, we shall have the fluxion of the momentum of the spheroid $mnf\frac{d}{2b}\pi\ (b^4\dot{x} - 4b^2x^2\dot{x} + 3x^4\dot{x})$, of which the fluent is $mnf\frac{d}{2b}\pi\left(b^4x - 4b^2\frac{x^3}{3} + \frac{3x^5}{5}\right)$. This expresses the momentum of the zone EA *a* Q, contained between the equator and the parallel of latitude A *a*. Now let x become $= b$, and we shall obtain the momentum of the hemispheroid $= mnf\frac{d}{2b}\pi\ (b^5 - \frac{4}{3}b^5 + \frac{1}{5}b^5)$, and that of the spheroid $= mnf\frac{d}{b}\pi\ (b^5 - \frac{4}{3}b^5 + \frac{1}{5}b^5) = \frac{4}{15}mnfd\pi b^4$.

This formula does not express any motion, but only a pressure tending to produce motion, and particularly tending to produce a libration by its action on the cohering matter of the earth, which is affected as a number of levers. It is similar to the common mechanical formula *w.d*, where *w* means a weight, and *d* its distance from the fulcrum of the lever.

It is worthy of remark, that the momentum of this protuberant matter is just $\frac{1}{5}$ of what it would be if it were all collected at the point O of the equator: for the matter in the spheroid is to that in the inscribed sphere as a^2 to b^2, and the contents of the inscribed sphere is $\frac{4}{3}\pi b^3$. Therefore $a^2 : a^2 - b^2 = \frac{4}{3}\pi b^3 : \frac{4}{3}\pi b^3\frac{a^2 - b^2}{a^2}$, which is the quantity of protuberant matter. We may, without sensible error, suppose $\frac{a^2 - b^2}{a} = 2d$;

Precession. $= 2d$; then the protuberant matter will be $\frac{4}{5}\pi b^2 d$. If all this were placed at O, the momentum would be $\frac{4}{5}\pi db^2 f \cdot OH \cdot HC, = \frac{4}{5} m n f d b^4$, becauſe $OH \cdot HC = m n b^2$; now $\frac{4}{5}$ is 5 times $\frac{4}{25}$.

Alſo, becauſe the ſum of all the rectangles $OH \cdot HC$ round the equator is half of as many ſquares of OC, it follows that the momentum of the protuberant matter placed in a ring round the equator of the ſphere or ſpheroid is one half of what it would be if collected in the point O or E; whence it follows that the momentum of the protuberant matter in its natural place is two-fifths of what it would be if it were diſpoſed in an equatorial ring. It was in this manner that Sir Iſaac Newton was enabled to compare the effect of the ſun's action on the protuberant matter of the earth, with his effect on a rigid ring of moons. The preceding inveſtigation of the momentum is nearly the ſame with his, and appears to us greatly preferable in point of perſpicuity to the fluxionary ſolutions given by later authors. Theſe indeed have the appearance of greater accuracy, becauſe they do not ſuppoſe all the protuberant matter to be condenſed on the ſurface of the inſcribed ſphere: nor were we under the neceſſity of doing this, only it would have led to very complicated expreſſions had we ſuppoſed the matter in each line AQ collected in its centre of oſcillation or gyration. We made a compenſation for the error introduced by this, which may amount to $\frac{1}{115}$ of the whole, and ſhould not be neglected, by taking d as equal to $\frac{a^2 - b^2}{2a}$ inſtead of $\frac{a^2 - b^2}{a + b}$. The conſequence is, that our formula is the ſame with that of the later authors.

Thus far Sir Iſaac Newton proceeded with mathematical rigour; but in the application he made two aſſumptions, or, as he calls them, hypotheſes, which have been found to be unwarranted. The firſt was, that when the ring of protuberant matter is connected with the inſcribed ſphere, and ſubjected to the action of the diſturbing force, the ſame quantity of motion is produced in the whole maſs as in the ring alone. The ſecond was, that the motion of the nodes of a rigid ring of moons is the ſame with the mean motion of the nodes of a ſolitary moon. But we are now able to demonſtrate, that it is not the quantity of motion, but of momentum, which remains the ſame, and that the nodes of a rigid ring move twice as faſt as thoſe of a ſingle particle. We proceed therefore to

31 Effects of the libratory momentum of the earth's protuberant matter.

Prob. 2. To determine the deviation of the axis, and the retrograde motion of the nodes which reſult from this libratory momentum of the earth's protuberant matter.

But here we muſt refer our readers to ſome fundamental propoſitions of rotatory motions which are demonſtrated in the article ROTATION.

If a rigid body is turning round an axis A, paſſing through its centre of gravity with the angular velocity a, and receives an impulſe which alone would cauſe it to turn round an axis B, alſo paſſing through its centre of gravity, with the angular velocity b, the body will now turn round a third axis C, paſſing thro' its centre of gravity, and lying in the plane of the axes A and B, and the ſine of the inclination of this third axis to the axis A will be to the ſine of inclination to the axis B as the velocity b to the velocity a.

32 When a rigid body is made to turn round any axis by the action of an external force, the quantity of momentum produced (that is, the ſum of the products of every particle by its velocity and by its diſtance from the axis) is equal to the momentum or ſimilar product of the moving force or forces. Precession.

If an oblate ſpheroid, whoſe equatorial diameter is a and polar diameter b, be made to librate round an equatorial diameter, and the velocity of that point of the equator which is fartheſt from the axis of libration be v, the momentum of the ſpheroid is $\frac{4}{15}\pi a^2 b^2 v$. 33

The two laſt are to be found in every elementary book of mechanics.

Let AN a n (fig. 4.) be the plane of the earth's equator, cutting the ecliptic CNK n in the line of the nodes or equinoctial points N n. Let OAS be the ſection of the earth by a meridian paſſing through the ſun, ſo that the line OCS is in the ecliptic, and CA is an arch of an hour-circle or meridian, meaſuring the ſun's declination. The ſun not being in the plane of the equator, there is, by prop. 1. a force tending to produce a libration round an axis ZO z at right angles to the diameter A a of that meridian in which the ſun is ſituated, and the momentum of all the diſturbing forces is $\frac{4}{15} m n f d \pi b^4$. The product of any force by the moment $\dot{t}$ of its action expreſſes the momentary increment of velocity; therefore the momentary velocity, or the velocity of libration generated in the time $\dot{t}$ is $\frac{4}{15} m n f d \pi b^4 \dot{t}$. This is the abſolute velocity of a point at the diſtance 1 from the axis, or it is the ſpace which would be uniformly deſcribed in the moment $\dot{t}$, with the velocity which the point has acquired at the end of that moment. It is double the ſpace actually deſcribed by the libration during that moment; becauſe this has been an uniformly accelerated motion, in conſequence of the continued and uniform action of the momentum during this time. This muſt be carefully attended to, and the neglect of it has occaſioned very faulty ſolutions of this problem. Plate CCCCXIV

Let v be the velocity produced in the point A, the moſt remote from the axis of libration. The momentum excited or produced in the ſpheroid is $\frac{4}{15}\pi a^2 b^2 v$ (as above), and this muſt be equal to the momentum of the moving force, or to $\frac{4}{15} m n f d \pi b^4 \dot{t}$; therefore we obtain $v = \frac{\frac{4}{15} m n f d \pi b^4 \dot{t}}{\frac{4}{15}\pi a^2 b^2}$, that is, $v = m n f d \dot{t} \frac{b^2}{a^2}$ or very nearly $m n f d \dot{t}$, becauſe $\frac{b^2}{a^2} = 1$ very nearly. Alſo, becauſe the product of the velocity and time gives the ſpace uniformly deſcribed in that time, the ſpace deſcribed by A in its libration round Z z is $m n f d \dot{t}^2$, and the angular velocity is $\frac{m n f d \dot{t}}{a}$.

Let $\dot{r}$ be the momentary angle of diurnal rotation. The arch A r, deſcribed by the point A of the equator in this moment $\dot{t}$ will therefore be $a\dot{r}$, that is, $a \times \dot{r}$, and the velocity of the point A is $\frac{a\dot{r}}{\dot{t}}$, and the angular velocity of rotation is $\frac{\dot{r}}{\dot{t}}$.

Here then is a body (fig. 5.) turning round an axis OP, perpendicular to the plane of the equator $z o z$, and therefore ſituated in the plane ZP z; and it turns round this

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this axis with the angular velocity $\frac{\dot{r}}{\dot{t}}$. It has received an impulſe, by which alone it would librate round the axis Z z, with the angular velocity $\frac{mnfdt}{a}$. It will therefore turn round neither axis (n° 31.), but round a third axis OP', paſſing through O, and lying in the plane ZP z, in which the other two are ſituated, and the ſine P'Π of its inclination to the axis Z z will be to the ſine P'p of its inclination to the axis OP of rotation as $\frac{\dot{r}}{\dot{t}}$ to $\frac{mnfdt}{a}$.

Now A, in fig. 4. is the ſummit of the equator both of libration and rotation; $mnfdt^2$ is the ſpace deſcribed by its libration in the time t; and ar is the ſpace or arch A r (fig. 4.) deſcribed in the ſame time by its rotation: therefore, taking A r to A c (perpendicular to the plane of the equator of rotation, and lying in the equator of libration), as ar to $mnfdt^2$, and completing the parallelogram A r m c, A m will be the compound motion of A (n° 31.), and $ar : mndft^2 = 1 : \frac{mnfdt^2}{ar}$, which will be the tangent of the angle m A r, or of the change of poſition of the equator. But the axes of rotation are perpendicular to their equator; and therefore the angle of deviation w is equal to this angle r A m. This appears from fig. 5.; for Π P' : P'p = O p : P'p, = OP : tan. POP; and it is evident that $ar : mnfdt^2 = \frac{\dot{r}}{\dot{t}} : mnfd\frac{t}{a}$, as is required by the compoſition of rotations.

In conſequence of this change of poſition, the plane of the equator no longer cuts the plane of the ecliptic in the line N n. The plane of the new equator cuts the former equator in the line AO, and the part AN of the former equator lies between the ecliptic and the new equator AN', while the part A n of the former equator is above the new one A n'; therefore the new node N', from which the point A was moving, is removed to the weſtward, or farther from A; and the new node n', to which A is approaching, is alſo moved weſtward, or nearer to A; and this happens in every poſition of A. The nodes, therefore, or equinoctial points, continually ſhift to the weſtward, or in a contrary direction to the rotation of the earth; and the axis of rotation always deviates to the eaſt ſide of the meridian which paſſes through the ſun.

This account of the motions is extremely different from what a perſon ſhould naturally expect. If the earth were placed in the ſummer ſolſtice, with reſpect to us who inhabit its northern hemiſphere, and had no rotation round its axis, the equator would begin to approach the ecliptic, and the axis would become more upright; and this would go on with a motion continually accelerating, till the equator coincided with the ecliptic. It would not ſtop here, but go as far on the other ſide, till its motion were extinguiſhed by the oppoſing forces; and it would return to its former poſition, and again begin to approach the ecliptic, playing up and down like the arm of a balance. On this account this motion is very properly termed *libration*; but this very ſlow libration, compounded with the incomparably ſwifter motion of diurnal rotation, produces a third motion extremely different from both. At firſt the north pole of the earth inclines forward toward the ſun; after a long courſe of years it will incline to the left hand, as viewed from the ſun, and be much more inclined to the ecliptic, and the plane of the equator will paſs through the ſun. Then the ſouth pole will come into view, and the north pole will begin to decline from the ſun; and this will go on (the inclination of the equator diminiſhing all the while) till, after a courſe of years, the north pole will be turned quite away from the ſun, and the inclination of the equator will be reſtored to its original quantity. After this the phenomena will have another period ſimilar to the former, but the axis will now deviate to the right hand. And thus, although both the earth and ſun ſhould not move from their places, the inhabitants of the earth would have a complete ſucceſſion of the ſeaſons accompliſhed in a period of many centuries. This would be prettily illuſtrated by an iron ring poiſed very nicely on a cap like the card of a mariner's compaſs, having its centre of gravity coinciding with the point of the cap, ſo that it may whirl round in any poſition. As this is extremely difficult to execute, the cap may be pierced a little deeper, which will cauſe the ring to maintain a horizontal poſition with a very ſmall force. When the ring is whirling very ſteadily, and pretty briſkly, in the direction of the hours of a watch-dial, hold a ſtrong magnet above the middle of the nearer ſemicircle (above the 6 hour point) at the diſtance of three or four inches. We ſhall immediately obſerve the ring riſe from the 9 hour point, and ſink at the 3 hour point, and gradually acquire a motion of preceſſion and nutation, ſuch as has been deſcribed.

Preceſſion.

If the earth be now put in motion round the ſun, or the ſun round the earth, motions of libration and deviation will ſtill obtain, and the ſucceſſion of their different phaſes, if we may ſo call them, will be perfectly analogous to the above ſtatement. But the quantity of deviation, and change of inclination, will now be prodigiouſly diminiſhed, becauſe the rapid change of the ſun's poſition quickly diminiſhes the diſturbing forces, annihilates them by bringing the ſun into the plane of the equator, and brings oppoſite forces into action.

We ſee in general that the deviation of the axis is always at right angles to the plane paſſing through the ſun, and that the axis, inſtead of being raiſed from the ecliptic, or brought nearer to it, as the libration would occaſion, deviates ſidewiſe; and the equator, inſtead of being raiſed or depreſſed round its eaſt and weſt points, is twiſted ſidewiſe round the north and ſouth points; or at leaſt things have this appearance: but we muſt now attend to this circumſtance more minutely.

The compoſition of rotation ſhows us that this change of the axis of diurnal rotation is by no means a tranſlation of the former axis (which we may ſuppoſe to be the axis of figure) into a new poſition, in which it again becomes the axis of diurnal motion; nor does the equator of figure, that is, the moſt prominent ſection of the terreſtrial ſpheroid, change its poſition, and in this new poſition continue to be the equator of rotation. This was indeed ſuppoſed by Sir Iſaac Newton; and this ſuppoſition naturally reſulted from the train of reaſoning which he adopted. It was ſtrictly true of a ſingle moon, or of the imaginary orbit attached to it; and therefore Newton ſuppoſed that the whole earth did in this manner deviate from its former poſi-

Precession. tion, ſtill, however, turning round its axis of figure. In this he has been followed by Walmeſly, Simpſon, and moſt of his commentators. D'Alembert was the firſt who entertained any ſuſpicion that this might not be certain; and both he and Euler at laſt ſhowed that the new axis of rotation was really a new line in the body of the earth, and that its axis and equator of figure did not remain the axis and equator of rotation. They aſcertained the poſition of the real axis by means of a moſt intricate analyſis, which obſcured the connection of the different poſitions of the axis with each other, and gave us only a kind of momentary information. Father Friſius turned his thoughts to this problem, and fortunately diſcovered the compoſition of rotations as a general principle of mechanical philoſophy. Few things of this kind have eſcaped the penetrating eye of Sir Iſaac Newton. Even *this* principle had been glanced at by him. He affirms it in expreſs terms with reſpect to a body that is perfectly ſpherical (cor. 22. prop. 66. B. I.) But it was reſerved for Friſius to demonſtrate it to be true of bodies of any figure, and thus to enrich mechanical ſcience with a principle which gives ſimple and elegant ſolutions of the moſt difficult problems.

But here a very formidable objection naturally offers itſelf. If the axis of the diurnal motion of the heavens is not the axis of the earth's ſpheroidal figure, but an imaginary line in it, round which even the axis of figure muſt revolve; and if this axis of diurnal rotation has ſo greatly changed its poſition, that it now points at a ſtar at leaſt 12 degrees diſtant from the pole obſerved by Timochares, how comes it that the equator has the very ſame ſituation on the ſurface of the earth that it had in ancient times? No ſenſible change has been obſerved in the latitudes of places.

The anſwer is very ſimple and ſatisfactory: Suppoſe that in 12 hours the axis of rotation has changed from the poſition PR (fig. 6.) to pr, ſo that the north pole, inſtead of being at P, which we may ſuppoſe to be a particular mountain, is now at p. In this 12 hours the mountain P, by its rotation round pr, has acquired the poſition π. At the end of the next 12 hours, the axis of rotation has got the poſition $\pi\rho$, and the axis of figure has got the poſition pr, and the mountain P is now at p. Thus, on the noon of the following day, the axis of figure PR is in the ſituation which the real axis of rotation occupied at the intervening midnight. This goes on continually, and the axis of figure follows the poſition of the axis of rotation, and is never further removed from it than the deviation of 12 hours, which does not exceed $\frac{1}{100}$th part of one ſecond, a quantity altogether imperceptible. Therefore the axis of figure will always ſenſibly coincide with the axis of rotation, and no change can be produced in the latitudes of places on the ſurface of the earth.

Plate CCCCXIV

34 Application of this reaſoning to nutation and preceſſion.

We have hitherto conſidered this problem in the moſt general manner; let us now apply the knowledge we have gotten of the deviation of the axis or of the momentary action of the diſturbing force to the explanation of the phenomena: that is, let us ſee what preceſſion and what nutation will be accumulated after any given time of action.

For this purpoſe we muſt aſcertain the preciſe deviation which the diſturbing forces are competent to produce. This we can do by comparing the momentum of libration with the gravitation of the earth to the ſun, and this with the force which would retain a body on the equator while the earth turns round its axis. Preceſſion.

The gravitation of the earth to the ſun is in the proportion of the ſun's quantity of matter M directly, and to the ſquare of the diſtance A inverſely, and may therefore be expreſſed by the ſymbol $\frac{M}{A^2}$. The diſturbing force at the diſtance 1 from the plane of illumination is to the gravitation of the earth's centre to the ſun as 3 to A, (A being meaſured on the ſame ſcale which meaſures the diſtance from the plane of illumination). Therefore $\frac{3M}{A^3}$ will be the diſturbing force f of our formula.

Let p be the centrifugal force of a particle at the diſtance 1 from the axis of rotation; and let t and T be the times of rotation and of annual revolution, viz. ſidereal day and year. Then $p : \frac{M}{A^2} = \frac{1}{t^2} : \frac{A}{T^2}$. Hence we derive $\frac{3M}{A^3} = 3p\frac{t^2}{T^2}$. But ſince $\dot{r}$ was the angular velocity of rotation, and conſequently $1 \times \dot{r}$ the ſpace deſcribed, and $\frac{1 \times \dot{r}}{t}$ the velocity; and ſince the centrifugal force is as the ſquare of the velocity divided by the radius, (this being the meaſure of the generated velocity, which is the proper meaſure of any accelerating force), we have $p = \frac{1 \times \dot{r}^2}{1^2 \times t^2}, = \frac{\dot{r}^2}{t^2}$, and $f = \frac{3\dot{r}^2}{t^2} \times \frac{t^2}{T^2}$. Now the formula $f m n d \frac{\dot{t}^2}{a}$ expreſſed the ſine of the angle. This being extremely ſmall, the ſine may be conſidered as equal to the arc which meaſures the angle. Now, ſubſtitute for it the value now found, viz. $\frac{3\dot{r}^2}{\dot{t}^2} \times \frac{\dot{t}^2}{T^2}$, and we obtain the angle of deviation $\dot{w} = \dot{r}\frac{3t^2}{T^2} mn \frac{d}{a}$, and this is the ſimpleſt form in which it can appear. But it is convenient, for other reaſons, to expreſs it a little differently: d is nearly equal to $\frac{a^2 - b^2}{2a^2}$, therefore $\dot{w} = \dot{r} \times \frac{3}{2}\frac{t^2}{T^2} mn \frac{a^2 - b^2}{a^2}$, and this is the form in which we ſhall now employ it.

The ſmall angle $\dot{r}\frac{3t^2}{2T^2} mn \frac{a^2 - b^2}{a^2}$ is the angle in which the new equator cuts the former one. It is different at different times, as appears from the variable part mn, the product of the ſine and coſine of the ſun's declination. It will be a maximum when the declination is in the ſolſtice, for mn increaſes all the way to 45°, and the declination never exceeds $23\frac{1}{2}$. It increaſes, therefore, from the equinox to the ſolſtice, and then diminiſhes.

Let ESL (fig. 7.) be the ecliptic, EAC the equator, BAD the new poſition which it acquires by the momentary action of the ſun, cutting the former in the angle BAE $= \dot{r}\frac{3}{2}\frac{t^2}{T^2} mn \frac{a^2 - b^2}{a^2}$. Let S be the ſun's place in the ecliptic, and AS the ſun's declination, the meridian AS being perpendicular to the equator. Let $\frac{a^2 - b^2}{a^2}$ be k. The angle BAE is then $= \dot{r}\frac{3t^2}{2T^2} kmn$. In the

Precession. the spherical triangle BAE we have sin. B : sin. AE = sin. A : sin. BE, or = A : BE, because very small angles and arches are as their sines. Therefore BE, which is the momentary precession of the equinoctial point E, is equal to $A \frac{\text{sin. AE}}{\text{sin. B}}$, $= \dot{r} \times \frac{3t^2}{2T^2} k m n$, $\frac{\text{sin. R. ascens.}}{\text{sin. obl. ecl.}}$.

35 Various modes of application. The equator EAC, by taking the position BAD, recedes from the ecliptic in the colure of the solstices CL, and CD is the change of obliquity or the nutation. For let CL be the solstitial colure of BAD, and $c\,l$ the solstitial colure of EAC. Then we have sin. B : sin. E = sin. LD : sin. $l\,c$; and therefore the difference of the arches LD and $l\,c$ will be the measure of the difference of the angles B and E. But when BE is indefinitely small, CD may be taken for the difference of LD and $l\,c$, they being ultimately in the ratio of equality. Therefore CD measures the change of the obliquity of the ecliptic, or the nutation of the axis with respect to the ecliptic.

The real deviation of the axis is the same with the change in the position of the equator, Pp being the measure of the angle EAB. But this not being always made in a plane perpendicular to the ecliptic, the change of obliquity generally differs from the change in the position of the axis. Thus when the sun is in the solstice, the momentary change of the position of the equator is the greatest possible; but being made at right angles to the plane in which the obliquity of the ecliptic is computed, it makes no change whatever in the obliquity, but the greatest possible change in the precession.

36 In order to find CD the change of obliquity, observe that in the triangle CAD, R : sin. AC, or R : cos. AE = sin. A : sin. CD, = A : CD (because A and CD are exceedingly small). Therefore the change of obliquity (which is the thing commonly meant by nutation) CD = A × cos. AE, $= \dot{r} \frac{3t^2}{2T^2} kmn$, cos. AE' $= \dot{r} \frac{3t^2}{2T^2}$ k × sin. declin. × cos. declin. × col. R. ascens.

37 But it is more convenient for the purposes of astronomical computation to make use of the sun's longitude SE. Therefore make

The sun's longitude ES	- -	=	z
Sine of sun's long.	- -	=	x
Cosine	- - $\sqrt{1-x^2}$	=	y
Sine obliq. eclipt.	- - $23\frac{1}{2}$	=	p
Cosine obliq.	- - -	=	q

38 In the spherical triangle EAS, right angled at A (because AS is the sun's declination perpendicular to the equator), we have R : sin. ES = sin. E : sin. AS, and sin. AS = $p\,x$. Also R : cos. AS = cos. AE : cos. ES, and cos. ES or y = cos. AS × cos. AE. Therefore $p\,x\,y$ = sin. AS × cos. AS × cos. AE, = mn × cos. AE. Therefore the momentary nutation CD $= \dot{r} \times \frac{3t^2}{2T^2} kpxy$.

39 We must recollect that this angle is a certain fraction of the momentary diurnal rotation. It is more convenient to consider it as a fraction of the sun's annual motion, that so we may directly compare his motion on the ecliptic with the precession and nutation corresponding to his situation in the heavens. This change is easily made, by augmenting the fraction in the ratio of the sun's angular motion to the motion of rotation, or multiplying the fraction by $\frac{T}{t}$; therefore Precession. the momentary nutation will be $\dot{r} \frac{3t}{2T} kpxy$. In this value $\frac{3tkp}{2T}$ is a constant quantity, and the momentary nutation is proportional to $x\,y$, or to the product of the sine and cosine of the sun's longitude, or to the sine of twice the sun's longitude; for $x\,y$ is equal to half the sine of twice z.

If therefore we multiply this fraction by the sun's momentary angular motion, which we may suppose, with abundant accuracy, proportional to z, we obtain the fluxion of the nutation, the fluent of which will express the whole nutation while the sun describes the arch z of the ecliptic, beginning at the vernal equinox. Therefore, in place of y put $\sqrt{1-x^2}$, and in place of $\dot{z}$ put $\frac{\dot{x}}{\sqrt{1-x^2}}$, and we have the fluxion of the nutation for the moment when the sun's longitude is z, and the fluent will be the whole nutation. The fluxion resulting from this process is $\frac{3tkp}{2T} x \dot{x}$, of which the fluent is $\frac{3tkp}{4T} x^2$. This is the whole change produced on the obliquity of the ecliptic while the sun moves along the arch z ecliptic, reckoned from the vernal equinox. When this arch is 90°, x^2 is 1, and therefore $\frac{3tkp}{4T}$ is the nutation produced while the sun moves from the equinox to the solstice.

The momentary change of the axis and plane of the equator (which is the measure of the changing force) is $\frac{3tk}{2T} mn$.

The momentary change of the obliquity of the ecliptic is $\frac{3tkp}{2T} x \dot{x}$

The whole change of obliquity is $\frac{3tkp}{4T} x^2$.

41 The real and momentary changes greatest at the solstices and at the equinoxes, nothing. Hence we see that the force and the real momentary change of position are greatest at the solstices, and diminish to nothing in the equinoxes.

The momentary change of obliquity is greatest at the octants, being proportional to $x\,\dot{x}$ or to $x\,y$.

The whole accumulated change of obliquity is greatest at the solstices, the obliquity itself being then smallest.

42 Quantity of precession in a given time. We must in like manner find the accumulated quantity of the precession after a given time, that is, the arch BE for a finite time.

We have ER : CD = sin. EA : sin. CA (or cos. EA) = tan. EA : 1, and EB : ER = 1 : sin. B. Therefore EB : CD = tan. EA : sin. B. But tan. EA = cos. E × tan. ES, $= \text{cos. E} \times \frac{\text{sin. long.}}{\text{cos. long.}} = \frac{q\,x}{\sqrt{1-x^2}}$.

Therefore EB : CD $= \frac{q\,x}{\sqrt{1-x^2}} p$, and CD = EB : $\frac{\text{sin. obliq. eclip.}}{\text{tan. long. } \odot}$. If we now substitute for CD its value found in n° 40. viz. $\frac{3tkp}{2T} x \dot{x}$, we obtain EB $= \frac{3t}{2T} \times \frac{k q x^2 \dot{x}}{\sqrt{1-x^2}}$, the fluxion of the precession of the

Preceſſion. equinoxes occaſioned by the action of the ſun. The fluent of the variable part $\frac{x^2\dot{x}}{\sqrt{1-x^2}} = x\dot{y}$, of which the fluent is evidently a ſegment of a circle whoſe areh is z and ſine x, that is, $= \frac{z-x\sqrt{1-x^2}}{2}$, and the whole preceſſion, while the ſun deſcribes the arch z, is $\frac{3}{2}\frac{t}{T}\times\frac{kq}{2}\left(2-x\sqrt{1-x^2}.\right)$ This is the preceſſion of the equinoxes while the ſun moves from the vernal equinox along the arch z of the ecliptic.

In this expreſſion, which conſiſts of two parts, $\frac{3tkq}{4T}z$, and $\frac{3}{4}\frac{tkq}{T}\left(-x\sqrt{1-x^2}\right)$, the firſt is incomparably greater than the ſecond, which never exceeds 1″, and is always compenſated in the ſucceeding quadrant. The preceſſion occaſioned by the ſun will be $\frac{3tkq}{4T}z$, and from this expreſſion we ſee that the preceſſion increaſes uniformly, or at leaſt increaſes at the ſame rate with the ſun's longitude z, becauſe the quantity $\frac{3tkq}{4T}$ is conſtant.

43 Mode of uſing the formulæ. In order to make uſe of theſe formulæ, which are now reduced to very great ſimplicity, it is neceſſary to determine the values of the two conſtant quantities $\frac{3tkp}{4T}$, $\frac{3tkq}{4T}$, which we ſhall call N and P, as factors of the nutation and preceſſion. Now t is one ſidereal day, and T is $366\frac{1}{4}$. k is $\frac{a^2-b^2}{a^2}$, which according to Sir Iſaac Newton is $\frac{231^2-230^2}{231^2} = \frac{1}{115}$; p and q are the ſine and coſine of 23° 28′, viz. 0,39822 and 0,91729.

Theſe data give $N = \frac{1}{141030}$ and $P = \frac{1}{61224}$ of which the logarithms are 4.85069 and 5.21308, viz. the arithmetical complements of 5.14931 and 4.78692.

44 Example of the utility of the inveſtigation. Let us, for an example of the uſe of this inveſtigation, compute the preceſſion of the equinoxes when the ſun has moved from the vernal equinox to the ſummer ſolſtice, ſo that z is 90°, or 324000″.

Log 324000″ = z - -	5.51055
Log P - - -	5.21308
Log 5″,292 - - -	0.72363

The preceſſion therefore in a quarter of a year is 5,292 ſeconds; and, ſince it increaſes uniformly, it is 21″,168 annually.

45 Aſſumptions on which the computation proceeds. We muſt now recollect the aſſumptions on which this computation proceeds. The earth is ſuppoſed to be homogeneous, and the ratio of its equatorial diameter to its polar axis is ſuppoſed to be that of 231 to 230. If the earth be more or leſs protuberant at the equator, the preceſſion will be greater or leſs in the ratio of this protuberance. The meaſures which have been taken of the degrees of the meridian are very inconſiſtent among themſelves; and although a compariſon of them all indicates a ſmaller protuberancy, nearly $\frac{1}{311}$ inſtead of $\frac{1}{231}$, their differences are too great to leave much confidence in this method. But if this figure be thought more probable, the preceſſion will be reduced to about 17″ annually. But even though the figure of the earth were accurately determined, we have no authority to ſay that it is homogeneous. If it be denſer towards the centre, the momentum of the protuberant matter will not be ſo great as if it were equally denſe with the inferior parts, and the preceſſion will be diminiſhed on this account. Did we know the proportion of the matter in the moon to that in the ſun, we could eaſily determine the proportion of the whole obſerved annual preceſſion of $50\frac{1}{3}$″ which is produced by the ſun's action. But we have no unexceptionable data for determining this; and we are rather obliged to infer it from the effect which ſhe produces in diſturbing the regularity of the preceſſion, as will be conſidered immediately. So far, therefore, as we have yet proceeded in this inveſtigation, the reſult is very uncertain. We have only aſcertained unqueſtionably the law which is obſerved in the ſolar preceſſion. It is probable, however, that this preceſſion is not very different from 20″ annually; for the phenomena of the tides ſhow the diſturbing force of the ſun to be very nearly $\frac{2}{5}$ of the diſturbing force of the moon. Now 20″ is $\frac{2}{5}$ of 50″.

Preceſſion.

46 Effect of the moon's action on the protuberant matter of the earth. But let us now proceed to conſider the effect of the moon's action on the protuberant matter of the earth; and as we are ignorant of her quantity of matter, and conſequently of her influence in ſimilar circumſtances with the ſun, we ſhall ſuppoſe that the diſturbing force of the moon is to that of the ſun as m to 1. Then *(cæteris paribus)* the preceſſion will be to the ſolar preceſſion π in the ratio of the force and of the time of its action jointly. Let t and T therefore repreſent a periodical month and year, and the lunar preceſſion will be $= \frac{m\pi t}{T}$. This preceſſion muſt be reckoned on the plane of the lunar orbit, in the ſame manner as the ſolar preceſſion is reckoned on the ecliptic. We muſt alſo obſerve, that $\frac{m\pi t}{T}$ repreſents the lunar preceſſion only on the ſuppoſition that the earth's equator is inclined to the lunar orbit in an angle of $23\frac{1}{2}$ degrees. This is indeed the mean inclination; but it is ſometimes increaſed to above 28°, and ſometimes reduced to 18°. Now in the value of the ſolar preceſſion the coſine of the obliquity was employed. Therefore whatever is the angle E contained between the equator and the lunar orbit, the preceſſion will be $= \frac{m\pi t}{T}\cdot\frac{\text{Coſ. E}}{\text{Coſ. }23\frac{1}{2}^\circ}$, and it muſt be reckoned on the lunar orbit.

47 Now let ♈B (fig. 8.) be the immoveable plane of the ecliptic, ♈ED♎F the equator in its firſt ſituation, before it has been deranged by the action of the moon, AGRDBH the equator in its new poſition, after the momentary action of the moon. Let EGNFH be the moon's orbit, of which N is the aſcending node, and the angle N = 5° 8′ 46″.

Let N♈ the long. of the node be -	z
Sine N♈ - - - - -	x
Coſine N♈ - - - - -	y
Sine ♈ = $23\frac{1}{2}$ - - -	a
Coſine ♈ - - - -	b
Sine N = 5.8.46 - - -	c
Coſine N - - - -	d
Circumference to radius 1, = 6,28 -	e

Force

Preceſſion.

Force of the moon - - m
Solar preceſſion (ſuppoſed $= 14\frac{1}{2}''$ by obſervation) - - - π
Revolution of $\mathbb{C} = 27^{d}\frac{1}{3}$ - - t
Revolution of $\odot = 366\frac{1}{4}$ - - T
Revolution of N = 18 years 7 months - n

48 Lunar preceſſion in a month reduced to the ecliptic.

In order to reduce the lunar preceſſion to the ecliptic, we muſt recollect that the equator will have the ſame inclination at the end of every half revolution of the ſun or of the moon, that is, when they paſs through the equator, becauſe the ſum of all the momentary changes of its poſition begins again each revolution. Therefore if we neglect the motion of the node during one month, which is only $1\frac{1}{2}$ degrees, and can produce but an inſenſible change, it is plain that the moon produces, in one half revolution, that is, while ſhe moves from H to G, the greateſt difference that ſhe can in the poſition of the equator. The point D, therefore, half-way from G to H, is that in which the moveable equator cuts the primitive equator, and DE and DF are each 90°. But S being the ſolſtitial point, ΥS is alſo 90°. Therefore DS = ΥE. Therefore, in the triangle DGE, we have ſin. ED : ſin. G = ſin. EG : ſin. D, = EG : D. Therefore D = EG × ſin. G, = EG × ſin. E nearly. Again, in the triangle ΥDA we have ſin. A : ſin. ΥD (or cof. ΥE) = ſin. D : ſin. ΥA, = D : ΥA. Therefore

$$\Upsilon A = \frac{D \cdot \text{Cof. } \Upsilon E}{\text{Sin. A}}, = \frac{EG \cdot \text{Sin. E} \cdot \text{Cof. } \Upsilon E}{\text{Sin. } 23\frac{1}{2}}, = \frac{m\pi t}{T} \frac{\text{Sin. E} \cdot \text{Cof. E} \cdot \text{Cof. } \Upsilon E}{\text{Sin. } \Upsilon \cdot \text{Cof. } \Upsilon}.$$

49 This is the lunar preceſſion produced in the courſe of one month, eſtimated on the ecliptic, not conſtant like the ſolar preceſſion, but varying with the inclination or the angle E or F, which varies both by a change in the angle N, and alſo by a change in the poſition of N on the ecliptic.

50 Nutation in the ſame time,

We muſt find in like manner the nutation SR produced in the ſame time, reckoned on the colure of the ſolſtices RL. We have R : ſin. DS = D : RS, and RS = D · ſin. DS, = D · ſin. ΥE. But D = EG · ſin. E. Therefore RS = EG · ſin. E · ſin. ΥE, $= \frac{m\pi t \text{ Cof. E}}{T \cdot \text{Cof. } \Upsilon}$ × ſin. E × ſin. ΥE. In this expreſſion we muſt ſubſtitute the angle N, which may be conſidered as conſtant during the month, and the longitude ΥN, which is alſo nearly conſtant, by obſerving that ſin. E : ſin. ΥN = ſin. N : ſin. ΥE. Therefore $RS = \frac{m\pi t}{T} \times \frac{\text{Sin. N} \cdot \text{Sin. } \Upsilon N \cdot \text{Cof. E.}}{\text{Cof. } \Upsilon}$

But we muſt exterminate the angle E, becauſe it changes by the change of the poſition of N. Now, in the triangle ΥEN we have cof. E = cof. ΥN · ſin. N · ſin. Υ — cof. N · cof. Υ, $= yca - db$. And becauſe the angle E is neceſſarily obtuſe, the perpendicular will fall without the triangle, the coſine of E will be negative, and we ſhall have cof. E = $bd - acy$. Therefore the nutation for one month will be $= \frac{m\pi t}{T} \times \frac{cx(bd - acy)}{b}$, the node being ſuppoſed all the while in N.

51 May be conſidered as momentary parts of the moon's action.

Theſe two expreſſions of the monthly preceſſion and nutation may be conſidered as momentary parts of the moon's action, correſponding to a certain poſition of the node and inclination of the equator, or as the fluxions of the whole variable preceſſion and nutation, while the node continually changes its place, and in the ſpace of 18 years makes a complete tour of the heavens. Preceſſion.

52 Preceſſion and nutation compared,

We muſt, therefore, take the motion of the node as the fluent of compariſon, or we muſt compare the fluxions of the node's motion with the fluxions of the preceſſion and nutation; therefore, let the longitude of the node be z, and its monthly change = ż; we ſhall then have $t : n = \dot{z} : e$, and $t = \frac{n\dot{z}}{e}$, $= \frac{n\dot{x}}{e\sqrt{1-x^2}}$. Let T be = 1, in order that n may be 18,6, and ſubſtitute for t its value in the fluxion of the nutation, by putting $\sqrt{1-x^2}$ in place of y. By this ſubſtitution we obtain $m\pi n \frac{c}{eb} \left(\frac{dbx\dot{x}}{\sqrt{1-x^2}} - acx\dot{x} \right)$. The fluent of this is $m\pi n \frac{c}{eb} \left(-db\sqrt{1-x^2} - \frac{acx^2}{2} \right)$. (*Vide* Simpſon's Fluxions, § 77). But when x is $= o$, the nutation muſt be $= o$, becauſe it is from the poſition in the equinoctial points that all our deviations are reckoned, and it is from this point that the periods of the lunar action recommences. But if we make $x = o$ in this expreſſion, the term $-\frac{acx^2}{2}$ vaniſhes, and the term $-db\sqrt{1-x^2}$ becomes $= -db$; therefore our fluent has a conſtant part $+db$; and the complete fluent is $m\pi n \frac{c}{eb} \left(db - db\sqrt{1-x^2} - \frac{acx^2}{2} \right)$. Now this is equal to $m\pi n \frac{c}{eb}$ (db × verſed ſine, $z - \frac{1}{4}ac$ × verſed ſine 2z): For the verſed ſine of z is equal to (1 — cof. z); and the ſquare of the ſine of an arch is $\frac{1}{2}$ the verſed ſine of twice that arch.

53 This, then, is the whole nutation while the moon's aſcending node moves from the vernal equinox to the longitude $\Upsilon N = z$. It is the expreſſion of a certain number of ſeconds, becauſe π, one of its factors, is the ſolar preceſſion in ſeconds; and all the other factors are numbers, or fractions of the radius 1; even e is expreſſed in terms of the radius 1.

54 The fluxion of the preceſſion, or the monthly preceſſion, is to that of the nutation as the cotangent of ΥE is to the ſine of Υ. This alſo appears by conſidering figure 7. Pp meaſures the angle A, or change of poſition of the equator; but the preceſſion itſelf, reckoned on the ecliptic, is meaſured by Po, and the nutation by po; and the fluxion of the preceſſion is equal to the fluxion of nutation × $\frac{\text{cot. } \Upsilon E}{\text{ſine } \Upsilon}$, but cot. $\Upsilon E = \frac{ad + bcy}{cx}$; therefore $\frac{\text{cot. } \Upsilon E}{\text{ſine } \Upsilon} = \frac{ad + bc\sqrt{1-x^2}}{cx}$: This, multiplied into the fluxion of the nutation, gives $\frac{m\pi n}{abe} \left(\frac{abd^2}{\sqrt{1-xx}} + (b^2 - a^2)\, dc - abc^2 \cdot \sqrt{1-xx} \right) \dot{x}$ for the monthly preceſſion. The fluent of this $\frac{m\pi n}{abe} \left(ad^2bz + (b^2 - a^2)\, dcx - \frac{1}{2}abc^2 z - \frac{1}{2}abc^2 x\sqrt{1-x^2} \right)$, or it is equal to $\frac{m\pi n}{abe} \left((d^2 - \frac{1}{2}c^2)\, abz + (b^2 - a^2)\, dcz - \frac{1}{4}abc^2 \text{ ſine } 2z \right)$.

Precession. 55 Let us now expreſs this in numbers: When the node has made a half revolution, we have $z = 180°$, whoſe verſed ſine is 2, and the verſed ſine of $2z$, or $360°$, is $= 0$; therefore, after half a revolution of the node, the nutation (n° 52.) becomes $\frac{m \pi n c}{e b} 2bd$. If, in this expreſſion, we ſuppoſe $m = 2\frac{1}{2}$, and $\pi = 14\frac{1}{2}''$, we ſhall find the nutation to be $19\frac{1}{2}''$.

56 Now the obſerved nutation is about $18''$. This requires m to be $2\frac{1}{13}$, and $\pi = 16\frac{1}{4}''$. But it is evident, that no aſtronomer can pretend to warrant the accuracy of his obſervations of the nutation within $1''$.

To find the lunar preceſſion during half a revolution of the node, obſerve, that then z becomes $= \frac{e}{2}$, and the ſine of z and of $2z$ vaniſh, d^2 becomes $1 - c^2$, and the preceſſion becomes $\frac{m \pi n}{2}(d^2 - \frac{1}{2}c^2)$, $= \frac{m \pi n}{2}(1 - \frac{1}{2}c^2)$, and the preceſſion in 18 years is $m \pi n \overline{1 - \frac{1}{2}c^2}$.

57 We ſee, by comparing the nutation and preceſſion for nine years, that they are as $\frac{4cd}{e}$ to $1 - \frac{1}{2}c^2$ nearly as 1 to $17\frac{1}{3}$. This gives $313''$ of preceſſion, correſponding to $18''$, the obſerved nutation, which is about $35''$ of preceſſion annually produced by the moon.

58 Gives the diſturbing force and matter of the moon. And thus we ſee, that the inequality produced by the moon in the preceſſion of the equinoxes, and, more particularly, the nutation occaſioned by the variable obliquity of her orbit, enables us to judge of her ſhare in the whole phenomenon; and therefore informs us of her diſturbing force, and therefore of her quantity of matter. This phenomenon, and thoſe of the tides, are the only facts which enable us to judge of this matter: and this is one of the circumſtances which has cauſed this problem to occupy ſo much attention. Dr Bradley, by a nice compariſon of his obſervations with the mathematical theory, as it is called, furniſhed him by Mr Machin, found that the equation of preceſſion computed by that theory was too great, and that the theory would agree better with the obſervations, if an ellipſe were ſubſtituted for Mr Machin's little circle. He thought that the ſhorter axis of this ellipſe, lying in the colure of the ſolſtices, ſhould not exceed $16''$. Nothing can more clearly ſhow the aſtoniſhing accuracy of Bradley's obſervations than this remark: for it reſults from the theory, that the pole muſt really deſcribe an ellipſe, having its ſhorter axis in the ſolſtitial colure, and the ratio of the axes muſt be that of 18 to 16,8; for the mean preceſſion during a half revolution of the node is $\frac{m \pi n}{2}(d^2 - \frac{c^2}{2})$; and therefore, for the longitude z, it will be $\frac{z m \pi n}{e}(d^2 - \frac{c^2}{2})$; when this is taken from the true preceſſion for that longitude (n° 54.), it leaves the equation of preceſſion $\frac{m \pi n}{abe}\left((b^2 - a^2)\, d\, c \cdot \text{ſine } z - \frac{1}{4}abc \text{ ſine } 2z\right)$; therefore, when the node is in the ſolſtice, and the equation greateſt, we have it $= \frac{m \pi n c d}{abe}(b^2 - a^2)$. We here neglect the ſecond term as inſignificant.

59 Greateſt equation of preceſſion. This greateſt equation of preceſſion is to $\frac{2 m \pi n c d}{e}$, the nutation of $18''$, as $b^2 - a^2$ to $2ab$; that is, as radius to the tangent of twice the obliquity of the ecliptic. This gives the greateſt equation of preceſſion $16'',8$, not differing half a ſecond from Bradley's obſervations. Preceſſion || Predeſtination.

Thus have we attempted to give ſome account of this curious and important phenomenon. It is curious, becauſe it affects the whole celeſtial motions in a very intricate manner, and received no explanation from the more obvious application of mechanical principles, which ſo happily accounted for all the other appearances. It is one of the moſt illuſtrious proofs of Sir Iſaac Newton's ſagacity and penetration, which catched at a very remote analogy between this phenomenon and the libration of the moon's orbit. It is highly important to the progreſs of practical and uſeful aſtronomy, becauſe it has enabled us to compute tables of ſuch accuracy, that they can be uſed with confidence for determining the longitude of a ſhip at ſea. This alone fixes its importance: but it is ſtill more important to the philoſopher, affording the moſt inconteſtable proof of the univerſal and mutual gravitation of all matter to all matter. It left nothing in the ſolar ſyſtem unexplained from the theory of gravity but the acceleration of the moon's mean motion; and this has at laſt been added to the liſt of our acquſitions by Mr de la Place.

Quæ toties animos veterum torſere Sophorum,
Quæque ſcholas fruſtra rauco certamine vexant,
Obvia conſpicimus, nube pellente Matheſi,
Jam dubios nulla caligine prægravat error
Queis ſuperûm penetrare domos, atque ardua cœli
Scandere ſublimis genii conceſſit acumen.
Nec fas eſt propius mortali attingere divos.

Halley.

PRECIÆ, (*precius*, "early,)") the name of the 21ſt order in Linnæus's fragments of a natural method; conſiſting of primroſe, an early flowering plant, and a few genera which agree with it in habit and ſtructure, though not always in the character or circumſtance expreſſed in the title. See BOTANY, p. 461. col. 2.

PRECIPITANT, in chemiſtry, is applied to any liquor, which, when poured on a ſolution, ſeparates what is diſſolved, and makes it precipitate, or fall to the bottom of the veſſel.

PRECIPITATE, in chemiſtry, a ſubſtance which, having been diſſolved in a proper menſtruum, is again ſeparated from its ſolvent, and thrown down to the bottom of the veſſel, by pouring ſome other liquor upon it.

PRECIPITATION. See *CHEMISTRY-Index.*

PRECOGNITION, in Scots law. See LAW, Part III. n° CLXXXVI. 43.

PRECORDIA, in anatomy, a general name for the parts ſituated about the heart, in the forepart of the thorax: as the diaphragm, pericardium, and even the heart itſelf, with the ſpleen, lungs, &c.

PREDECESSOR, properly ſignifies a perſon who has preceded or gone before another in the ſame office or employment; in which ſenſe it is diſtinguiſhed from anceſtor.

PREDESTINATION, the decree of God, whereby he hath from all eternity unchangeably appointed whatſoever comes to paſs; and hath more eſpecially fore-ordained certain individuals of the human race to everlaſting

The doctrine ſtated.

PRECESSION of the EQINOXES. Plate CCCCXIV.

Fig. 1.

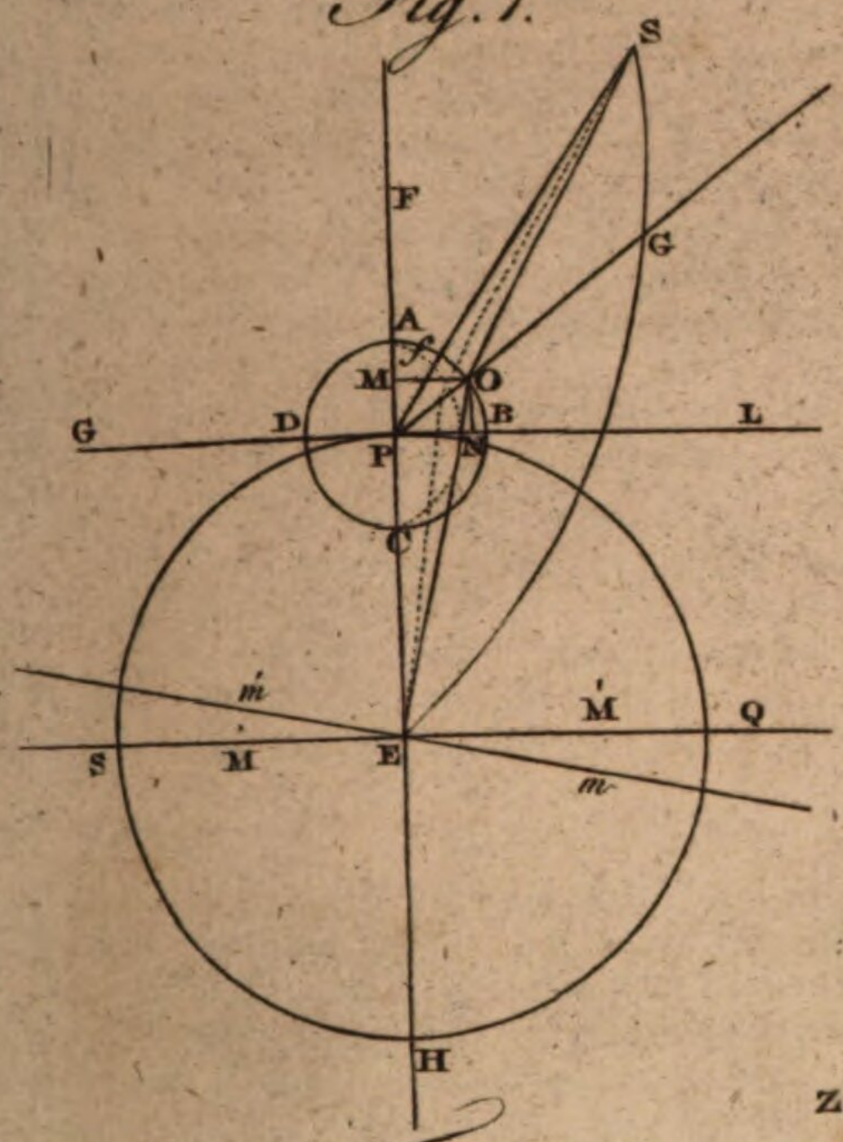


Fig. 3.

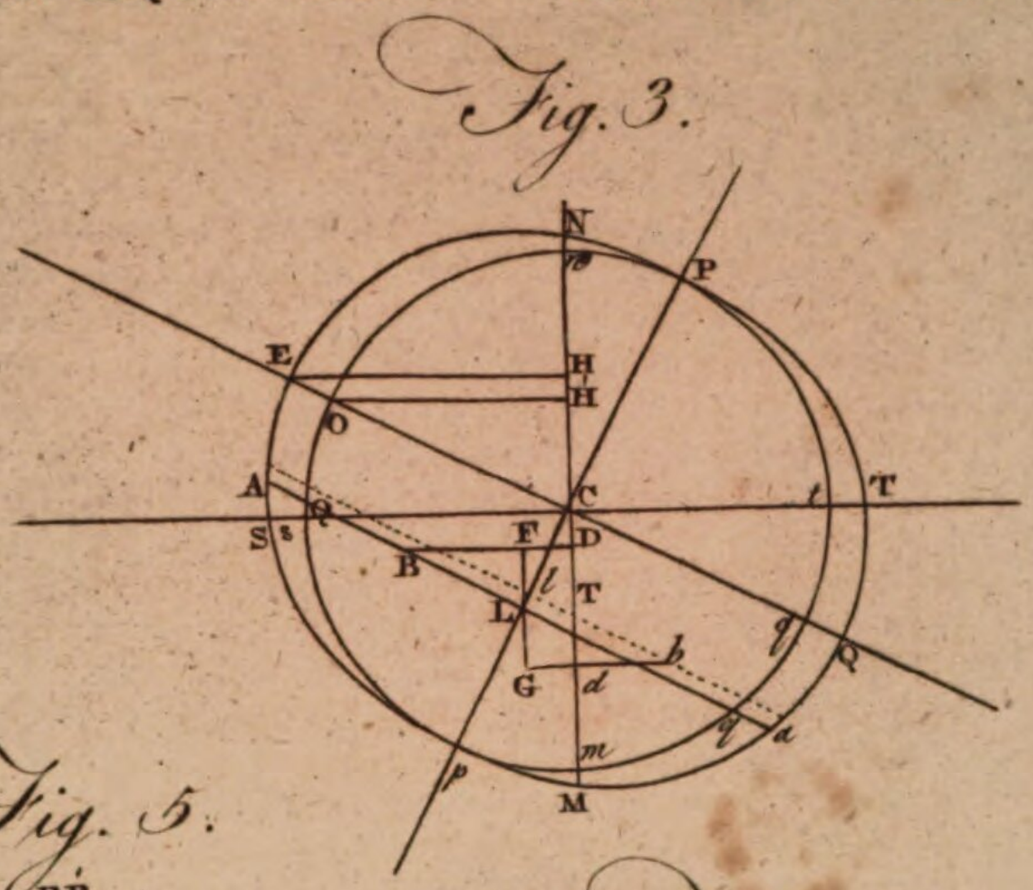


Fig. 5.

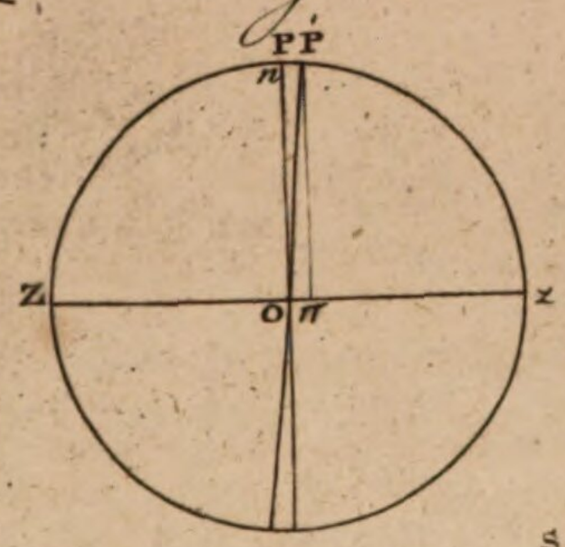


Fig. 4.

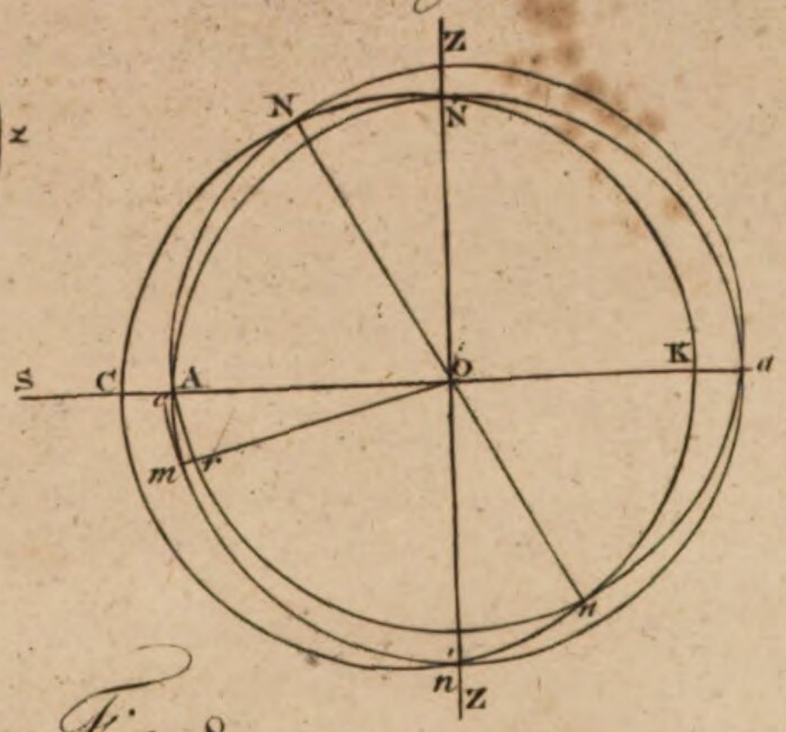


Fig. 7.

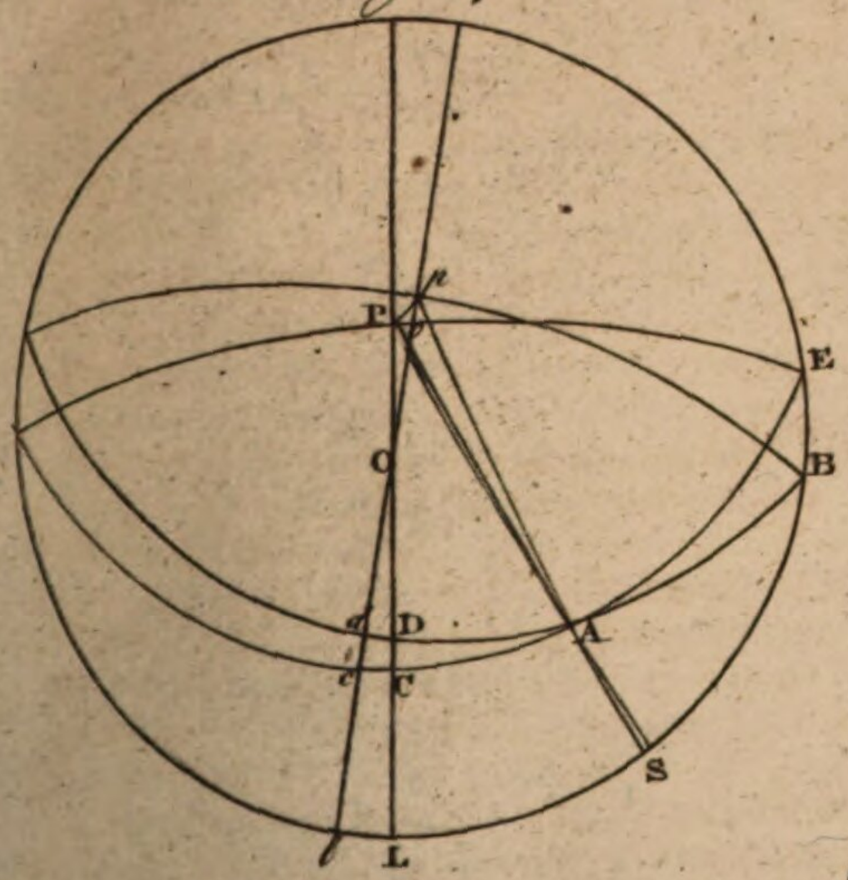
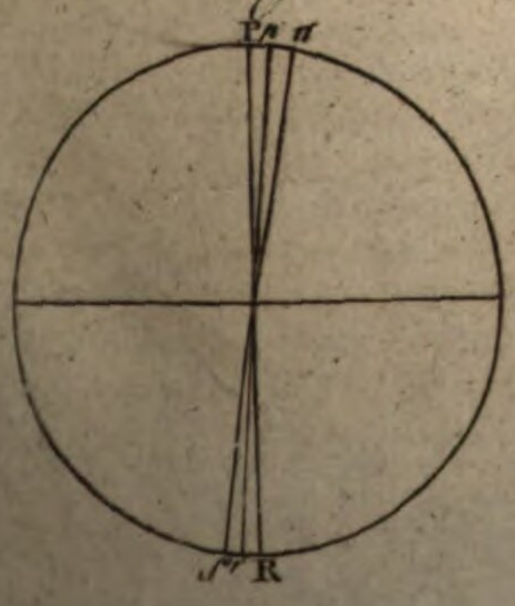


Fig. 8.

Fig. 2.

Fig. 6.



A.B. sculpt. Prin. Wales Sculptor fecit.

Predeſtination.

everlaſting happineſs, and hath paſſed by the reſt, and fore-ordained them to everlaſting miſery. The former of theſe are called the *elect*, and the latter are called the *reprobate*.

2 Not peculiar to Chriſtianity.

This doctrine is the ſubject of one of the moſt perplexing controverſies that has occurred among mankind. But it is not altogether peculiar to the Chriſtian faith. The opinion, that whatever occurs in the world at large, or in the lot of private individuals, is the reſult of a previous and unalterable arrangement by that Supreme Power which preſides over nature, has always been a favourite opinion among the vulgar, and has been believed by many ſpeculative men. Thus, in that beautiful ſcene in the ſixth book of the Iliad, Hector, taking leave of his wife and his child, ſpeaks thus:

> Andromache! my ſoul's far better part,
> Why with untimely ſorrows heaves thy heart?
> No hoſtile hand can antedate my doom,
> Till fate condemns me to the ſilent tomb.
> Fix'd is the term to all the race of earth,
> And ſuch the hard condition of our birth.
> No force can then reſiſt, no flight can ſave,
> All ſink alike, the fearful and the brave. l. 624.

The ancient Stoics, Zeno and Chryſippus, whom the Jewiſh Eſſenes ſeem to have followed, aſſerted the exiſtence of a Deity that, acting wiſely, but neceſſarily, contrived the general ſyſtem of the world; from which, by a ſeries of cauſes, whatever is now done in it unavoidably reſults. This ſeries, or concatenation of cauſes, they held to be neceſſary in every part; and that God himſelf is ſo much the ſervant of neceſſity, and of his own decrees, that he could not have made the ſmalleſt object in the world otherwiſe than it now is, much leſs is he able to alter any thing.

According to the words of Seneca, *Eadem neceſſitas et Deos alligat. Irrevocabilis divina pariter atque humana curſus vehit. Ille ipſe omnium conditor ac rector ſcripſit quidem fata ſed ſequitur. Semper paret, ſemel juſſit.* "The ſame chain of neceſſity conſtrains both gods and men. Its unalterable courſe regulates divine as well as human things. Even he who wrote the Fates, the Maker and Governor of all things, ſubmits to them. He did but once command, but he always obeys." The ſtoical fate differs, however, from the Chriſtian predeſtination in ſeveral points. They regarded the divine nature and will as a neceſſary part of a neceſſary chain of cauſes; whereas the Chriſtians conſider the Deity as the Lord and Ruler of the Univerſe, omnipotent and free, appointing all things according to his pleaſure. Being doubtful of the immortality of the ſoul, the Stoics could have no idea of the doctrine of election and reprobation; nor did they ever doubt their own freedom of will, or power of doing good as well as evil, as we ſhall preſently ſee the Chriſtian predeſtinarians have done.

Mahomet introduced into his Koran the doctrine of an abſolute predeſtination of the courſe of human affairs. He repreſented life and death, proſperity and adverſity, and every event that befals a man in this world, as the reſult of a previous determination of the one God who rules over all; and he found this opinion the beſt engine for inſpiring his followers with that contempt of danger which, united to their zeal, has extended the empire of their faith over the faireſt portion of the habitable globe.

Predeſtination.

The controverſy concerning predeſtination firſt made its appearance in the Chriſtian church about the beginning of the fifth century†. Pelagius a Britiſh, and Cœleſtius an Iriſh, monk, both lived at Rome during that period, and poſſeſſed great celebrity on account of their piety and learning. They taught that the opinion is falſe, which aſſerts, that human nature is neceſſarily corrupted by a depravity derived from our firſt parents.—They contended, that men are born at preſent in a ſtate as pure as that in which Adam was originally created; and that they are not leſs qualified than he was for fulfilling all righteouſneſs, and for reaching the moſt ſublime eminence of piety and virtue: that the external grace of God, which is given unto all, and attends the preaching of the goſpel, is neceſſary to call forth the attention and exertions of men; but that we do not want the aſſiſtance of any internal grace to purify the heart, and to give it the firſt impulſe towards what is good. Having fled into Africa on account of the Goths, who at that time invaded Italy, A. D. 410, Cœleſtius remained at Carthage as a Preſbyter; but Pelagius went into the Eaſt, where he ſettled, and proſpered under the patronage of John biſhop of Jeruſalem, to whom his ſentiments were agreeable. On the contrary, the celebrated Auguſtine, biſhop of Hippo, ſtrenuouſly aſſerted the depravity of human nature ſince the fall of the firſt man, the neceſſity of a ſpecial interpoſition of divine grace to enable us to do any one good action; and conſequently, that none could obtain ſalvation excepting thoſe whom God has thought fit to elect, and upon whom he beſtows this grace. The diſpute was carried on with great zeal. Zozimus biſhop of Rome decided at firſt in favour of Pelagius and Cœleſtius, whoſe followers were called *Pelagians*; but he afterwards altered his opinion: and by the activity of Auguſtine, the council of Epheſus was called, at which the opinion of his antagoniſts was formally condemned.

3 When firſt agitated in the church.

† *Moſheim. Inſtit. Hiſt. Eccl.*

4 Auguſtine a predeſtinarian,

In the courſe of the ſame century, theſe opinions aſſumed a variety of forms and modifications. One party, called *Predeſtinarians*, carried Auguſtine's doctrine fully farther than he himſelf had ventured to do in expreſs words; and aſſerted, that God had not only predeſtinated the wicked to *puniſhment*, but alſo that he had decreed that they ſhould commit thoſe very *ſins* on account of which they are hereafter to be puniſhed.—Another party moderated the doctrine of Pelagius, and were called *Semipelagians*. Their peculiar opinion is expreſſed in a different manner by different writers; but all the accounts ſufficiently agree. Thus, ſome repreſent them as maintaining that inward grace is not neceſſary to the firſt beginning of repentance, but only to our progreſs in virtue. Others ſay, that they acknowledged the power of grace, but ſaid that faith depends upon ourſelves, and good works upon God; and it is agreed upon all hands, that theſe Semipelagians held that predeſtination is made upon the foreſight of good works. The aſſiſtance of Auguſtine, though then far advanced in life, was called in to combat theſe tenets, and he wrote ſeveral treatiſes upon the ſubject. In all theſe he ſtrenuouſly maintained, that the predeſtination of the elect was independent of any foreſight

of

Predeſtination.

of their good works, but was according to the good pleaſure of God only; and that perſeverance comes from God, and not from man. Thereafter the doctrine of Auguſtine, or St Auſtin as he is often called, became general. He was the oracle of the ſchoolmen. They never ventured to differ from him in ſentiment; they only pretended to diſpute about the true ſenſe of his writings.

5 And all the earlieſt reformers, but more eſpecially Calvin.

The whole of the earlieſt reformers maintained theſe opinions of Auguſtine. They aſſumed under Luther a more regular and ſyſtematic form than they had ever formerly exhibited. But as the Lutherans afterwards abandoned them, they are now known by the name of *Calviniſtic Doctrines*, from John Calvin of Geneva. He aſſerted, that the everlaſting condition of mankind in a future world was determined from all eternity by the unchangeable decree of the Deity, ariſing from his ſole good pleaſure or free will. Being a man of great ability, induſtry, and eloquence, Geneva, where he taught, and which was a free ſtate, ſoon became the reſort of all the men of letters belonging to the reformed churches, and was a kind of ſeminary from which miſſionaries iſſued to propagate the Proteſtant doctrines through Europe. Their ſucceſs was ſuch, that, excepting a part of Germany, the principles of all the reformed churches are profeſſedly Calviniſtic or Predeſtinarian.

6 Riſe of the Arminians.

The opponents of the doctrine of predeſtination among the Proteſtants uſually receive the appellation of *Arminians* or *Remonſtrants*. They derive the firſt of theſe appellations from James Arminius, who was, A. D. 1602, appointed * profeſſor of theology at Leyden. He was violently oppoſed by Gomer his colleague, and died A. D. 1609. After his death, the controverſy was conducted with great eagerneſs on both ſides. The Calviniſts, however, gradually prevailed. A ſynod was called at Dort, A. D. 1618, to which the moſt celebrated divines of different countries were invited. There, in a great meaſure by the authority and influence of Maurice prince of Orange, the Arminians were condemned as heretics; for by this time ambitious and powerful men found themſelves politically intereſted in this religious conteſt. The Arminians preſented to this ſynod a remonſtrance, containing a ſtatement of their faith upon the ſubjects in diſpute; and from this they derived the appellation of *Remonſtrants*. This ſtatement contained the following five articles: 1. That God from all eternity predeſtinated thoſe to everlaſting ſalvation whom he foreſaw would believe in Chriſt unto the end of their lives; and predeſtinated obſtinate unbelievers to everlaſting puniſhment. 2. Jeſus Chriſt died for the whole human race, and for every individual of it, but believers alone reap the benefit of his death. 3. No man can produce faith in his mind by his own free will, but it is neceſſary that man, who is by nature wicked and unfit for acting or thinking aright, ſhould be regenerated by the grace of the Holy Spirit, imparted by God for Chriſt's ſake. 4. This divine grace conſtitutes the ſource, the progreſs, and the fulfilment, of all that is good in man; but it is not irreſiſtible in its operation. 5. Believers, by the aſſiſtance of the Holy Spirit, are abundantly fitted for every good work; but whether it is poſſible for thoſe who have once been truly ſuch to fall away, and to periſh finally, is not clear,

* *Relatio Hiſtorica de Origine et Progreſſu Controverſiarum in Phœderato Belgio de Prædeſtinatione Philippi a Limborch.*

and muſt be better inquired into by ſearching the ſacred ſcriptures.

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In oppoſition to theſe, a counter-remonſtrance was preſented, containing the opinions of the Calviniſts, which was approved of by the ſynod. The ſubſtance of it was afterwards adopted, and in nearly the ſame expreſſions, into the Confeſſion of Faith compiled by the aſſembly of divines which met at Weſtminſter, A. D. 1643, and which every clergyman and probationer for the miniſtry in Scotland is at preſent required to ſubſcribe previous to his admiſſion. To give as clear and as fair an idea as poſſible of the Calviniſtic doctrine upon this head, we tranſcribe the following paſſage from that Confeſſion: "God from all eternity did, by the moſt wiſe and holy counſel of his own will, freely and unchangeably ordain whatſoever comes to paſs; yet ſo, as thereby neither is God the author of ſin, nor is violence offered to the will of the creatures, nor is the liberty or contingency of ſecond cauſes taken away, but rather eſtabliſhed. Although God knows whatſoever may or can come to paſs upon all ſuppoſed conditions; yet hath he not decreed any thing becauſe he foreſaw it as future, or that which would come to paſs upon ſuch conditions. By the decree of God, for the manifeſtation of his glory, ſome men and angels are predeſtinated unto everlaſting life, and others are fore-ordained to everlaſting death. Theſe angels and men, thus predeſtinated and fore-ordained, are particularly and unchangeably deſigned; and their number is ſo certain and definite, that it cannot be either increaſed or diminiſhed. Thoſe of mankind that are predeſtinated unto life, God, before the foundaton of the world was laid, according to his eternal and immutable purpoſe, and the ſecret counſel and good pleaſure of his will, hath choſen, in Chriſt, unto everlaſting glory, out of his mere free grace and love, without any foreſight of faith, or good works, or perſeverance in either of them, or any other thing in the creature, as conditions or cauſes moving him thereunto; and all to the praiſe of his glorious grace. As God hath appointed the elect unto glory, ſo hath he, by the eternal and moſt free purpoſe of his will, fore-ordained all the means thereunto. Wherefore, they who are elected, being fallen in Adam, are redeemed by Chriſt, are effectually called unto faith in Chriſt, by his ſpirit working in due ſeaſon; are juſtified, adopted, ſanctified, and kept, by his power through faith unto ſalvation. Neither are any other redeemed by Chriſt effectually called, juſtified, adopted, ſanctified, and ſaved, but the elect only. The reſt of mankind, God was pleaſed, according to the unſearchable counſel of his own will, whereby he extendeth or with-holdeth mercy as he pleaſeth for the glory of his ſovereign power over his creatures, to paſs by, and to ordain them to diſhonour and wrath for their ſin, to the praiſe of his glorious juſtice."

7 Calviniſtic doctrine of predeſtination.

8 Supralapſarians and Sublapſarians.

There are two kinds of Calviniſts or Predeſtinarians, viz. the *Supralapſarians*, who maintain that God did originally and expreſsly decree the fall of Adam, as a foundation for the diſplay of his juſtice and mercy; while thoſe who maintain that God only *permitted* the fall of Adam, are called *Sublapſarians*, their ſyſtem of decrees concerning election and reprobation being, as it were, ſubſequent to that event. But, as Dr Prieſtley juſtly remarks, if we admit the divine preſcience, there

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is not, in fact, any difference between the two ſchemes; and accordingly that diſtinction is now ſeldom mentioned.

9 Diſputes in the church of Rome on the ſubject

Nor was the church of Rome leſs agitated by the conteſt about predeſtination than the firſt Proteſtants were. The council of Trent was much perplexed how to ſettle the matter without giving offence to the Dominicans, who were much attached to the doctrine of Auguſtine, and poſſeſſed great influence in the council. After much diſpute, the great object came to be, how to contrive ſuch a decree as might give offence to nobody, although it ſhould decide nothing. Upon the whole, however, they ſeem to have favoured the Semipelagian ſcheme. Among other things, it was determined, that good works are of themſelves meritorious to eternal life; but it is added, by way of ſoftening, that it is through the goodneſs of God that he makes his own gifts to be merits in us. Catarin revived at that council an opinion of ſome of the ſchoolmen, that God choſe a ſmall number of perſons, ſuch as the bleſſed virgin, the apoſtles, &c. whom he was determined to ſave without any foreſight of their good works; and that he alſo wills that all the reſt ſhould be ſaved, providing for them all neceſſary means, but they are at liberty to uſe them or not. This is called the *Baxterian* ſcheme in England, from one of its promoters there. But at all events, the council of Trent ſeems to have been extremely anxious that any opinions entertained among them concerning predeſtination might have as little influence as poſſible upon practical morality. "Let no man (ſay they), while he remains in this mortal ſtate, preſume that he is among the number of the elect, and that therefore he cannot ſin, or ſin without repentance; for it cannot be known who are elected without a ſpecial revelation from God." Seſ. 6. c. 13.

The Jeſuits at firſt followed the opinion of Auguſtine; but they afterwards forſook it. *Molina*, one of their order, was the author of what is called the *middle ſcheme*, or the doctrine of *a grace ſufficient for all men*, but ſubject to the freedom of the human will. *Janſenius*, a doctor of Louvain, oppoſed the Jeſuits with great vigour, and ſupported the doctrine of Auguſtine. He wrote in a very artful manner. He declared, that he did not preſume to ſtate his own ſentiments upon the ſubject; he pretended only to explain and publiſh the ſentiments of that great father of the church St Auguſtine. But the Jeſuits, in conſequence of that inviolable ſubmiſſion to the authority of the pope which they always maintained, had ſufficient intereſt at Rome to procure the opinions of Janſenius to be condemned there; but with this addition ſubjoined, that nothing was thereby intended to be done in prejudice of the doctrine of St Auguſtine. This produced an abſurd diſpute about the pope's infallibility in matters of fact. The Janſeniſts affirmed, that the Pope had made a miſtake in condemning the opinions of Janſenius as different from thoſe of Auguſtine; whereas in truth they are the ſame, and the one cannot be condemned without the other. But the Jeſuits affirmed, that the pope is no leſs infallible in points of fact than he is in queſtions of faith; and he having decided, that the opinions of Janſenius are different from thoſe of St Auguſtine, every good Catholic is bound to believe accordingly that they are different. Theſe diſputes have never been fully ſettled, and ſtill divide the Roman Catholic churches. Some of the ableſt ſupporters of predeſtination have appeared among the Janſeniſts, and particularly among the gentlemen of Port-Royal.

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10 Engliſh and Scotch reformers predeſtinarians.

With regard to Great Britain, the earlieſt Engliſh reformers were in general Sublapſarians, although ſome of them were Supralapſarians. But the rigid Predeſtinarians have been gradually declining in number in that church, although they ſtill ſubſcribe the 39 articles of their faith, which are unqueſtionably Calviniſtic. The celebrated Scotch reformer John Knox having been educated at Geneva, eſtabliſhed in this country the doctrine of predeſtination in its ſtricteſt form: and it has probably been adhered to with more cloſeneſs in Scotland than in any country in Europe.

Of late years, however, the diſpute concerning predeſtination has aſſumed a form conſiderably different from that which it formerly poſſeſſed. Inſtead of being conſidered as a point to be determined almoſt entirely by the ſacred ſcriptures, in the hands of a number of able writers, it has in a great meaſure reſolved itſelf into a queſtion of natural religion, under the head of the philoſophical liberty or neceſſity of the will (A); or, whether all human actions are or are not neceſſarily determined

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(A) Dr Prieſtley, the moſt celebrated Neceſſarian of the age, has written a whole ſection of his *Illuſtrations*, with a view to ſhow, that between "the two ſchemes of Calviniſtic predeſtination and philoſophical neceſſity, there is no ſort of reſemblance, except that the future happineſs or miſery of all men is certainly foreknown and appointed by God. In all other reſpects (ſays he) they are moſt eſſentially different; and even where they agree in the *end*, the difference in the *manner* by which that end is accompliſhed is ſo very great, that the *influence* of the two ſyſtems on the minds of thoſe that adopt and act upon them is the reverſe of one another." The Calviniſtic doctrine of predeſtination, according to a very authentic ſtatement of that doctrine*, is, that "God, for his own glory, hath *fore-ordained whatſoever comes to paſs*." The ſcheme of philoſophical neceſſity, as ſtated by an intimate friend and warm admirer of Dr Prieſtley's, is, "That *every thing* is *predetermined* by the Divine Being; that whatever has been, muſt have been; and that whatever will be, muſt be; that *all events* are *pre-ordained* by infinite wiſdom and unlimited goodneſs; that the will, in all its determinations, is governed by the ſtate of mind; that this ſtate of mind is in every inſtance determined by the Deity; and that there is a continued chain of cauſes and effects, of motives and actions, inſeparably connected, and originating from the condition in which we are brought into exiſtence by the Author of our being." The *author* or *compiler* of the ſame book affirms, "That all motion indeed originates in the Deity; that the Deity is ſelf-moved; that he poſſeſſes the ſingular attribute underived of moving himſelf." But it is added in the very ſame paragraph from which this laſt ſentence is quoted, that "the very argument we employ to prove one underived ſource of motion and

* *Shorter Catechiſm of the Aſſembly of Divines at Weſtminſter.*

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termined by motives ariſing from the character which God has impreſſed on our minds, and the train of circumſtances amidſt which his providence has placed us? We have already diſcuſſed this point (ſee METAPHYSICS) by giving a candid ſtatement of the arguments on both ſides of the queſtion. We ſhall treat the ſubject of predeſtination in the ſame manner, avoiding as far as poſſible any recapitulation of what has been advanced under the head of *NECESSITY and Liberty*.

11 Points at iſſue between the predeſtinarians and their opponents.

From what has been already ſaid, it will appear that the points chiefly at iſſue between the parties are the following: Firſt, With what views and purpoſes did God create the world and frame his decrees concerning mankind? Did he contrive a great unalterable ſcheme of creation and providence only for the ſake of manifeſting his own glory and perfections? Or did he firſt conſider the free motions of thoſe rational agents whom he intended to create, and frame his decrees upon the conſideration of what they might chooſe or do in all the various circumſtances in which he intended to place them?—The ſecond and following queſtions are branches of this leading one. Did Chriſt die for a particular portion of the human race, who ſhall therefore certainly be ſaved? or was his death intended as a beneſit to all, from which none are excluded excepting thoſe who willingly reject it? Is the divine grace certainly and irreſiſtibly efficacious in all thoſe minds to which it is given? or does its effect depend upon the good uſe which men may or may not make of it? Can any good action be done without it? Do thoſe who have once received it certainly perſevere and obtain eternal ſalvation? or is it poſſible for any of them to fall away and periſh finally?

12 Arguments for the doctrine

WE ſhall begin by ſtating the argument on the ſide of the predeſtinarians, and in the language which they commonly uſe. But it is neceſſary to make this previous remark, that the general* objections to their doctrine are, that it is hoſtile to all our ideas of the juſtice of God, repreſenting him as a partial being, rewarding without merit, and puniſhing without ſin; that it renders him the author of evil, deſtroys moral diſtinctions, makes uſeleſs every effort on our part, makes every prayer abſurd, and even the preaching of the goſpel vain; ſeeing that all things are immutably fixed, and none can believe or be ſaved excepting the elect, and they muſt certainly and at all events be ſafe. Againſt all this they reaſon thus.

* *Calvini Reſponſ contra Pighium*, ad 2um lib.

The great and everlaſting Author of all things exiſted from eternity alone, independent and eſſentially perfect. As there was no other, he could only conſider himſelf and his own glory. He muſt therefore have deſigned all things in and for himſelf. To make him ſtay his determinations till he ſhould ſee what free creatures would do, is to make him decree with uncertainty, and dependently upon them, which falls ſhort of infinite perfection. He exiſted alone, and his councils could have no object excepting himſelf; he could only then conſider the diſplay of his own attributes and perfection. In doing this, as the end is more important than the means, Divine Wiſdom muſt begin its deſigns with that which is to come laſt in the execution of them; but the concluſion of all things at the laſt judgement will be the complete manifeſtation of the wiſdom, the goodneſs, and juſtice, of God: we muſt therefore ſuppoſe, that, in the order of things, he decreed that firſt, although with him, in the order of time, there is no firſt nor ſecond, but all is from eternity. When this great deſign was laid, the means were next deſigned. Creation, and its inhabitants of every order, form the means by which the author and diſpoſer of all things accompliſhes his will. But creatures in his ſight are nothing, and are figuratively ſaid to be leſs than nothing. We may entertain proud and elevated conceptions of our own dignity if we pleaſe; but if we in our deſigns regard not the duſt on which we tread, or the lives of ants and inſects, the omnipotent Lord of all, from whom we are more infinitely diſtant, muſt regard us as at leaſt equally inconſiderable, and only valuable as we ſerve the acccompliſhment of his great and myſterious purpoſes, which cannot be us or our aggrandiſement, but himſelf and his own glory.

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13 As neceſſary to explain the Divine attributes.

It is only by this view of the divine conduct that ſome of the attributes of God can be explained, or their exiſtence rendered poſſible. In the ſcriptures he claims the attribute of *preſcience* as his diſtinguiſhing prerogative: but there can be no preſcience of future contingencies; for it involves a contradiction to ſay, that things which are not certainly to be ſhould be certainly foreſeen. If they are certainly foreſeen, they *muſt* certainly be, and can therefore be no longer contingent. An uncertain foreſight is alſo an imperfect act, as it may be a miſtake, and is therefore inconſiſtent with divine perfection. On the other ſide the difficulty is eaſily explained. When God decrees that an event ſhall take place, its exiſtence becomes thenceforth certain, and as ſuch is certainly foreſeen. For it is an obvious abſurdity to ſay, that a thing happens freely, that is to ſay, that it may be or may not be, and yet that it is certainly foreſeen by God. He cannot foreſee things but as he decrees them, and conſequently gives them a future certainty of exiſtence; and therefore any preſcience antecedent to his decree muſt be rejected as impoſſible. Conditional decrees are farther abſurd, inaſmuch as they ſubject the purpoſes of God to the will and the actions of his creatures. Does he will, or wiſh that all mankind ſhould be ſaved, and ſhall they not all be ſaved? Infinite perfection can wiſh nothing but what it can execute; and if it is fit to wiſh, it is alſo fit to execute its wiſhes. We are indeed certainly informed by the ſcrip-

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and exiſtence, is a groſs ſoleciſm in logic; and that the aſcription of this power to the Divine Being is in fact nothing elſe than the leſs of two palpable *abſurdities* or rather *impoſſibilities*, if theſe could admit of degrees.†"

† *Eſſay on Philoſophical Neceſſity by Alexander Crombie*, A. M.

The piety of theſe aſſertions will be obvious, we are perſuaded, to every one of our readers; but to ſome it is poſſible that their conſiſtency may not be apparent. We would adviſe all ſuch "to peruſe once and again Dr Prieſtley's Illuſtrations," which, we have the beſt authority to ſay, will remove from their minds all libertarian prejudices, convince them "that the hypotheſis of neceſſity is incontrovertibly true," and ſhow them that all the defenders of that hypotheſis are in perfect harmony with themſelves and with one another!

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14 Chriſt died only for the elect. We conclude upon the ſame principles, that although the bleſſings reſulting from the death of Chriſt are offered to all, yet that intentionally and actually he only died for thoſe whom the Father had choſen and given to him to be ſaved by him. That Chriſt ſhould have *died in vain* is repreſented by the apoſtle Paul as a great abſurdity (Gal. ii. 21.): but if he died for all, he muſt have died in vain with regard to the greater part of mankind who are not to be ſaved by him. In ſo far as ſome inferior bleſſings are concerned, which through him are communicated, if not to all men, at leaſt to all Chriſtians, he may perhaps juſtly be ſaid to have died for all: but with regard to eternal ſalvation, his deſign, to avoid rendering it fruitleſs, could go no farther than the ſecret purpoſe and election of God. This is implied in theſe words, *all that are given me of my Father, thine they were, and thou gaveſt them me.* To theſe his interceſſion is limited; *I pray not for the world, but for thoſe that thou haſt given me; for they are thine, and all thine are mine, and mine are thine* (Jo. xvii. 9, 10.) Univerſal words are indeed uſed with regard to the death of Chriſt: but the reaſon is obvious, the Jewiſh religion was confined to the family and deſcendants of Abraham. In contradiction to this, the goſpel is ſaid to be preached to *every creature*, and *to all the world*; becauſe it is not limited to any one race or nation, and becauſe the apoſtles received a general commiſſion to teach it unto all who ſhould be willing to receive it. Theſe extenſive expreſſions can only be underſtood in this manner, becauſe in their ſtrict acceptation they have never been verified. Nor can their meaning be carried farther without an imputation upon the juſtice of God: for if he has received a ſufficient ſatisfaction for the ſins of the whole world, it is not juſt that all ſhould not be ſaved by it, or at leaſt have the offer of ſalvation made to them, that they may accept of it if they pleaſe.

But to return to the divine purpoſes and attributes in general: it is in vain to aſſert that God is partial and unjuſt while he prefers without merit, and predeſtinates to puniſhment thoſe who have not yet offended. The ſame error miſleads men here that has ſo often ſeduced them from the true path of ſcientific reſearch. Inſtead of ſubmitting to the patient and humble obſervation of nature, they boldly form ſome plauſible hypotheſis of their own, and vainly attempt to reconcile every appearance to their favourite ſyſtem. This mode of procedure never has proved, and never will prove, ſucceſsful in any branch of true philoſophy. We are not entitled to frame to ourſelves certain notions of the juſtice of God, and from theſe to decide that thus he muſt act and in no other manner. He takes no counſel from us concerning his conduct, and we have no right to rejudge his judgments. What he regards as juſt or unjuſt between himſelf and his creatures, is a queſtion of fact not to be known by ingenious conjectures, but by the cautious obſervations of the manner in which he acts in the courſe of his providence, and by attending to what he has declared concerning himſelf in the ſacred ſcriptures. If from theſe it ſhall appear that he does prefer where there is no merit, and reject where there is no crime; it will be in vain thereafter to aſſert that ſuch conduct is unjuſt: the fact will be on our ſide of the queſtion, and we ſhall leave thoſe to account for it who inſiſt that their limited reaſon is capable of comprehending all the myſterious ways of an Infinite Being. Predeſtination.

15 Great inequalities in the ordinary courſe of providence.

In the courſe of providence, then, we ſee the greateſt inequalities take place, and ſuch as appear altogether contradictory to our ideas of juſtice. We ſee the ſins of the fathers puniſhed in the perſons of the children, who often derive debilitated bodies from the intemperance of their parents, and corrupted manners from the example of their vices. God frequently afflicts good men in this life for a great length of time, as in the caſe of Job, only for the manifeſtation of his own glory, that their faith and patience may be made manifeſt. Some ſins are puniſhed with other ſins, and often with a courſe of ſevere miſeries in the perſons of thoſe who never committed them. We may transfer this from time to eternity; for if God may do for a little time what is inconſiſtent with our notions, and with our rules of juſtice, he may do it for a longer duration: ſince it is as impoſſible that he can be unjuſt for a day as for all eternity: and the ſame inequality of management appears in the great as in the private affairs of this world. During many ages almoſt the whole human race were loſt in the darkneſs of idolatry: even ſince the Chriſtian religion came into the world, how few nations have received it; and of theſe few, the number is ſtill ſmaller of thoſe who have enjoyed it in tolerable purity. If we conſider how many great nations remain under the deluſion contrived by Mahomet; if we reflect upon the idolatry of the Indies and of China, and the ſuperſtition of the Greek church, and of the church of Rome—we ſhall find that very few nations have poſſeſſed the moſt ordinary means of grace. Even the bleſſings of civilization, of ſcience, and of liberty, are ſo rarely ſcattered over the face of the earth, that it is to be regarded as a melancholy truth, that with a very few favoured exceptions the whole human race have hitherto been ſunk in the depth of barbariſm, ignorance, ſlavery, and idolatry. When the Arminians think fit to aſſert, then, that the doctrine of abſolute decrees is contrary to their ideas of the impartiality and juſtice of God, we can only anſwer that we are ſorry for them if they have formed ideas of the character of God which are contrary to the truth. We preſume not * like them to call his attributes before the tribunal of our underſtandings; we only obſerve the ways of his providence, and declare that thus ſtands the fact. If he leaves whole nations in darkneſs and corruption, and freely chooſes others to communicate the knowledge of himſelf to them, we need not be ſurpriſed if he act in the ſame manner with individuals. For ſurely the rejecting immenſe empires for ſo many ages is much more unaccountable than the ſelection of a few individuals, and the leaving others in ignorance and depravity. It is in vain to allege that he extends his mercy to thoſe who make the beſt uſe of the dim light which they have. This does not remove the difficulty of a choice and a preference; as it cannot be denied that their condition is very deplorable, and that the condition of others is much more hopeful: ſo that the myſterious doctrine of election and reprobation is an unqueſtionable truth under the government of God, ſeeing that great numbers of men are born in ſuch circumſtances that it is morally impoſſible they ſhould not periſh

* *Calvini Tract. de Eterna Dei Prædeſt.*

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riſh in them; whereas others are more happily ſituated and enlightened.

16 The language of Scripture ptedeſtinarian.

Nor are we left to common obſervation upon this point. The language of the ſacred ſcriptures is poſitive and clear. The whole reaſoning in the ninth chapter to the Romans reſolves all the acts of God's juſtice and mercy, his *hardening* as well as his *pardoning*, into an abſolute freedom and an unſearchable depth. More pointed expreſſions for this purpoſe can ſcarcely be conceived than thoſe actually made uſe of. *For the children being not yet born, neither having done any good or evil, that the purpoſe of God according to election might ſtand, not of works, but of him that calleth, it was ſaid, The elder ſhall ſerve the younger. As it is written, Jacob have I loved, but Eſau have I hated. What ſhall we ſay then? Is there unrighteouſneſs with God? God forbid. For he ſaith to Moſes, I will have mercy on whom I will have mercy, and I will have compaſſion on whom I will have compaſſion. So then it is not of him that willeth, nor of him that runneth, but of God that ſhoweth mercy; for the ſcripture ſaith unto Pharaoh, Even for this ſame purpoſe have I raiſed thee up, that I might ſhow my power in thee, and that my name might be declared throughout all the earth. Therefore hath he mercy on whom he will have mercy, and whom he will he hardeneth.*

17 An objection anſwered.

If any man ſhall ſtill be ſufficiently bold to declare that all this is contrary to what he is pleaſed to conſider as juſt and impartial, we can only reply to him in the words of the celebrated John Calvin of Geneva †. *Tibi moleſtum eſt ac odioſum, Deum plus poſſe et facere, quam mens tua capiat; æquali autem tuo interdum concedes, ut ſuo judicio fruatur. Et tu in tanto furore, Dei mentionem ullam facere audes?* "Is it painful to thee that the power and the works of God exceed thy limited capacity? Thou ſometimes ſuffereſt thine equal to judge of his own conduct for himſelf, and dareſt thou in thy folly to cenſure the ways of God?" Or rather we may reply in thoſe words of the apoſtle Paul which immediately follow the paſſage already quoted. *Thou wilt ſay then to me, Why doth he yet find fault? for who hath reſiſted his will? Nay but, O man, who art thou that replieſt againſt God? Shall the thing formed ſay to him that formed it, Why haſt thou made me thus? Hath not the potter power over the clay; of the ſame lump to make one veſſel unto honour, and another unto diſhonour?* Let theſe paſſages, and even the whole of the chapter now alluded to, be explained in any manner that is judged proper, ſtill their import with regard to the preſent argument will remain the ſame. If God loved Jacob ſo as to chuſe his poſterity to be his people, and rejected or hated Eſau and his poſterity, and this without regard to them or their future conduct, but merely in conſequence of the purpoſe and deſign of his election; if by the ſame purpoſe the Gentiles were to be grafted upon that ſtock from which the once favoured Jews were cut off; it will follow, not only that the great and myſterious decree of final election is unſearchably free and abſolute, but alſo that all the means of grace are granted or withheld in the ſame unlimited and free manner according to the ſovereign will and good pleaſure of God, independent of any foreſight of merit on our part. The words of our Saviour expreſs this: *I thank thee O Father, Lord of heaven and earth, becauſe thou haſt hid theſe things from the wiſe and prudent, and haſt revealed them unto babes:* The reaſon of which is given in the following words, *Even ſo, Father, for ſo it ſeemed good in thy ſight*, (Mat. xi. 26). The paſſage immediately preceding this, ſhows clearly that the means of grace are not beſtowed upon thoſe who, it is foreſeen, will make a good uſe of them; nor denied to thoſe who will make a bad uſe of them. *Wo unto thee Chorazin, wo unto thee Bethſaida: for if the mighty works which were done in you had been done in Tyre and Sidon, they would have repented long ago in ſackcloth and aſhes.* But the paſſages in ſcripture are innumerable, which declare that the whole character and deſtiny of every man is the reſult of the counſel and uncontrouled determination of God. The expreſſion is often repeated in the book of Exodus; God *hardened the heart of Pharaoh, ſo that he would not let his people go*, (Exod. iv. 21), &c. It is ſaid, that *God has made the wicked man for the day of evil*, (Prov. xvi. 4). On the other hand, it is ſaid, *as many believed the goſpel as were appointed to eternal life*, (Acts i. 48.) Some are ſaid to be *written in the book of life, of the Lamb ſlain from the foundation of the world* (Rev. xiii 8.) Every prayer that is uſed, or directed to be uſed, in ſcripture, is for a grace that opens our eyes, that turns the heart, that makes us to go, that leads us not into temptation, but delivers us from evil. All theſe expreſſions denote that we deſire more than a power or capacity to act, ſuch as is given to all men. Indeed we do not, and we cannot, pray earneſtly for that which we know all men as well as ourſelves poſſeſs at all times.

† *Ubi ſupra.*

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18 Sure efficacy of grace.

The *grace of God* is the medium by which his ſovereign will and abſolute decrees are accompliſhed. Accordingly, it is ſet forth in ſcripture by ſuch expreſſions as clearly denote its ſure efficacy; and that it does not depend upon us to uſe it or not at our pleaſure. It is ſaid to be a creation; *we are created unto good works, and we become new creatures:* It is called a regeneration, or a *new birth;* it is called a quickening and a reſurrection, as our former ſtate is compared to a feebleneſs, a blindneſs, and a death. God is ſaid *to work in us both to will and to do: His people ſhall be willing in the day of his power: He will write his laws in their hearts, and make them to walk in them.* In a paſſage already quoted, the human race are compared to a maſs of *clay* in the hands of the *potter*, who of the ſame lump makes at his pleaſure *veſſels of honour and diſhonour.* Theſe paſſages, and this laſt more particularly, prove that there is an abſolute and a conquering power in divine grace; and that the love of God conſtrains us, as St Paul expreſſes himſelf. Our Saviour compares the union and influence that he communicates to believers to the union of an head with the members, and of a root with the branches, which imparts an internal, a vital, and an efficacious influence. The outward means may indeed be rejected, but this overcoming grace never returns empty: theſe outward means coming from God, the reſiſting of them is ſaid to be the *reſiſting* of God, the *grieving* or *quenching of his ſpirit;* and in that ſenſe we may reſiſt the grace or favour of God; but we can never withſtand him when he intends to overcome us; *For the foundation of God ſtandeth ſure, having this ſeal, The Lord knoweth them that are his*, (2 Tim. ii. 19.) *Having predeſtinated us unto the adoption of children by Jeſus Chriſt himſelf, according to the good pleaſure of his will*, (Eph. i. 5.)

19 Perſeverance of the ſaints.

That the ſaints ſhall certainly perſevere unto the end is a neceſſary conſequence of abſolute decrees and of efficacious grace: all depends on God. He *of his own will begat us;* and with him *there is no variableneſs nor ſhadow of turning: whom he loves, he loves to the end:* and he has promiſed that he will never leave nor forſake thoſe to whom he becomes a God. Our Lord

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28 Arguments againſt the doctrine from the attributes of God.

THUS far we have defended the doctrine of predeſtination: we proceed next to ſtate the arguments uſually adduced in favour of the Arminian ſyſtem.

God is juſt, holy, and merciful. In ſpeaking of himſelf in ſcripture, he is pleaſed to make appeals to the human underſtanding, and to call upon men to reaſon with him concerning his ways. The meaning of this is, that men may examine his actions and his attributes with that meaſure of intelligence which they poſſeſs, and they will be forced to approve of them; nay, he propoſes himſelf to us as a pattern for our imitation. We are required to be holy as he is holy, and merciful as he is merciful: which is a proof that he accounts us not incapable of forming juſt notions at leaſt of theſe attributes. What then can we think of a juſtice that ſhall condemn us for a fact that we never committed? that deſigns firſt of all to be glorified by our being eternally miſerable, and which afterwards decrees that we ſhall commit ſins to juſtify this previous decree of our reprobation? For if God originally deſigns and determines all things, and if all his decrees are certainly effected, it is inconceivable how there ſhould be a juſtice in puniſhing that which he himſelf, by an antecedent and irreverſible decree, appointed to be done. Or, ſetting juſtice aſide, is it poſſible that a being of infinite holineſs, and who is *of purer eyes than to behold iniquity*, would by an antecedent decree fix our committing ſo many ſins, in ſuch a manner that it is not poſſible to avoid them? He repreſents himſelf in the ſcriptures as *gracious, merciful, ſlow to anger, and abundant in goodneſs and truth.* It is often ſaid, that *he deſires that no man ſhould periſh, but that all ſhould come to the knowledge of the truth*: this is even ſaid with the ſolemnity of an oath, *As I live, ſaith the Lord, I take no pleaſure in the death of ſinners.* What ſenſe can theſe words bear if we believe that God did by an abſolute decree doom ſo many of them to everlaſting miſery? If all things that happen ariſe out of the abſolute decree of God as their firſt cauſe, then we muſt believe that God takes pleaſure both in his own decrees and in the execution of them, conſequently that *he doth take pleaſure in the death of ſinners*; and this in expreſs contradiction to the moſt poſitive language of ſcripture. Beſides all this, what are we to think of the truth of God, and of the ſincerity of thoſe offers of grace and mercy, with the exhortations and expoſtulations upon them that occur ſo frequently in ſcripture, if we can imagine that by antecedent acts he determined that all theſe ſhould be ineffectual? In one word, are we to regard our exiſtence as a bleſſing, and to look up with gratitude to that paternal goodneſs which has placed us in a *land* of hope, which formed our nature, weak indeed and expoſed to many imperfections, but capable of riſing by virtuous efforts and by a patient continuance in well-doing to excellence and to high and immortal felicity? or, are we to curſe the hour in which we were born under the dominion of a maſter, who is not only ſevere, but abſurd, and even adds inſult to cruelty; who, after placing us in a goodly habitation, binds us hand and foot, locks the door, blocks up the windows, ſets fire to the fabric, and then very mercifully calls upon us to come forth leſt we periſh?

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It is not true that rational beings are nothing in the ſight of their Maker. Compared to his Almighty ſtrength and uncreated exiſtence, our powers do indeed diminiſh into weakneſs, and our years into a moment: yet although our intereſts may be unimportant in themſelves, the attributes of God with which they are connected are far from being ſo. There was no neceſſity for his calling us into exiſtence; but the inſtant he beſtowed upon us that gift, and conferred upon us faculties capable of riſing to happineſs by the contemplation of himſelf and of his works, he became our parent, and granted to us a right to look up to him for protection and mercy, and to hope that our exiſtence and our faculties were not beſtowed in vain. Nor will he trample upon the juſt and reaſonable hopes of the meaneſt of his creatures. He is watchful over our intereſts; he hath ſent his Son to die for us; his providence has been exerted for no other purpoſe but to promote our welfare; and there is joy in heaven even over one ſinner that repenteth. Let it be allowed, that the univerſe was formed for no other purpoſe but to promote the glory of God; that glory can ſurely be little promoted by the exertion of undiſtinguiſhing and blind acts of power, in the arbitrary appointment to eternal reprobation of millions of unreſiſting and undeſerving wretches *. Is it not more honourable to the Deity to conceive of him as the parent, guide, governor, and judge of free beings, formed after the likeneſs of himſelf, with powers of reaſon and ſelf-determination, than to conceive of him, as the former and conductor of a ſyſtem of conſcious machinery, or the mover and controuler of an univerſe of puppets, many of whom he is pleaſed to make completely miſerable? The moſt important and fundamental point of religion, conſidered as a ſpeculative ſcience, conſiſts in our forming high and juſt ideas of God and of his attributes, that from them we may underſtand the maxims of true and perfect morality. But were we to attempt to form our own natures upon the idea of the divine character that is given us by the doctrine of abſolute decrees, we would certainly become imperious, partial, and cruel; at leaſt we ſhould not readily learn the virtues of kindneſs, mercy, and compaſſion.

* *Correſpondence between Price and Prieſtley.*

21 The difficulty of preſcience ſolved.

It is true that, ſetting aſide predeſtination, it is not eaſy to ſhow how future contingencies ſhould be certainly

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certainly foreſeen; but it is obvious that ſuch foreſight involves no contradiction, (ſee METAPHYSICS, n° 308); and if the actions of men be free, we know from the train of prophecies, which in the ſacred ſcriptures appear to have been made in one age and fulfilled in another, that contingencies are foreſeen by that infinite Being who inhabiteth eternity, and to whom a thouſand years are but as one day. The prophecies concerning the death and ſufferings of Chriſt were fulfilled by the free acts of the Jewiſh prieſts and people: Theſe men ſinned in accompliſhing that event, which proves that they acted with their natural liberty. From theſe and all the other prophecies both in the old and new Teſtament, it muſt be confeſſed that future contingencies were certainly foreknown, but where to found that certainty cannot be eaſily reſolved. We doubt not, however, that we may ſafely refer it to the infinite perfection of the Divine mind. And it ought to be obſerved that this difficulty is of a very different nature from that to which our antagoniſts are reduced on their ſide of the argument. They are compelled to confeſs that they cannot reconcile their doctrine with the juſtice of God, an attribute the nature of which we clearly underſtand, and which is held forth to our imitation; whereas we are only at a loſs how to explain the mode in which the divine preſcience is exerted; an attribute which God claims as peculiarly his own, and which it is not to be expected that we ſhould be able in the ſmalleſt degree to comprehend. We can go farther than this. Heaven hath given to man two revelations of itſelf. The one conſiſts in the knowledge which we procure by the right uſe of our rational faculties; and the other is beſtowed by means of the ſacred ſcriptures. Without intending to derogate from the authority of inſpiration, it is fair to aſſert, that we are *more certain* that God is the author and beſtower of our reaſon, than that he is the author of the ſcriptures; at leaſt it is certain that the laſt cannot contradict the firſt, becauſe God cannot contradict himſelf. By the primary revelation from heaven then, that is, by our reaſon, we are informed that God is true, and juſt, and good. If an angel from heaven ſhould preach a doctrine contrary to this, we are entitled to ſay with the apoſtle, *let him be accurſed*. If our antagoniſts then ſhould ſucceed in proving that the doctrine of abſolute decrees, which repreſents the Deity as cruel and unjuſt, is contained in ſcripture, the conſequence would be, not that we would believe it, for that is impoſſible, but that we ſhould be reduced to the neceſſity of rejecting the authority of the ſcriptures, becauſe they contradict the previous ſure revelation of God, our reaſon. We believe that the doctrines contained in the ſcriptures are certainly true, becauſe they were taught by thoſe who wrought miracles and foretold future events in proof of their being inſpired by the God of truth. But miracles and prophecy are *direct* evidences of nothing but the *power* and *wiſdom* of their Author; and unleſs we know by other evidence, that this powerful and wiſe Being is likewiſe the father of truth and juſtice, we cannot be ſure that the ſcriptures, notwithſtanding their ſource, are any thing better than a tiſſue of falſehoods. The very arguments therefore by which predeſtination is ſupported, tend to ſap the foundation of that revelation from which its advocates pretend to draw them. The caſe is very different when no doctrine is aſſerted that is not contradictory to our reaſon, but only above it. For example, when we are told that God can create rational beings, that he attends without diſtraction to the minuteſt affairs that paſs in a thouſand worlds, that he knows all things, the paſt, the preſent, and the future, we do not preſume that we comprehend how he can do all this: but there is nothing in it that contradicts our reaſon; we ourſelves poſſeſs a certain degree of power, can attend at once to a certain number of objects, can in ſome caſes form very ſure conjectures about futurity, and we reſolve all the reſt into the infinite nature and perfections of God.

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It is farther to be obſerved, that preſcience does not make effects certain becauſe they are foreſeen; but they are foreſeen becauſe they are to be: ſo that the certainty of the preſcience is not the cauſe, but the conſequence of the certainty of the event. The Roman republic has fallen; but our knowledge or ignorance of that event does not render it more or leſs true and certain. That it was to fall, was as ſurely true before it happened as it is now; and had we known it beforehand, as many men of ſenſe probably did, it would neither have fallen ſooner nor later on that account. This ſhows that the knowledge which an intelligent being has of a paſt or future event need not have any influence upon the circumſtances that produce that event.

23 Conditional preſcience.

On ſome occaſions the ſcripture takes notice of a conditional preſcience *. God anſwered David, that Saul would come to Keilah, and that the men of Keilah would deliver him up: yet both the one and the other reſted upon the condition of his ſtaying there; and he going from thence, neither of them ever happened. Such alſo was the † prophecy of Jonah, at the failure of which he was ſo abſurdly offended: and ſuch was Chriſt's ſaying, That thoſe of Tyre and Sidon, Sodom and Gomorrah would have turned to him, if they had ſeen the miracles that he wrought in the towns of Galilee. Since, then, this preſcience may be ſo certain that it can never err nor miſlead the exertions of providence, and ſince by this, both the attributes of God are vindicated, and the due freedom of man is aſſerted, all difficulties ſeem to be thus eaſily removed.

* 1 Sam. xxiii. 11, 12.

† Chap. iii. 4.

22 Scripture cannot contradict the clear dictates of reaſon.

24 Chriſt died for the whole world.

With regard to the purpoſe of Chriſt's death, he is ſaid to be the *propitiation for the ſins of the whole world*; and the wicked are ſaid *to deny the Lord that bought them*. His death, as to its extent, is ſet in oppoſition to the ſins of *Adam*; ſo that as by the offence of one judgment came upon all men to condemnation, ſo by the righteouſneſs of one the free gift came upon all men to juſtification of life, (Rom, v. 18.) The *all* on the one ſide muſt be as extenſive as the *all* on the other: ſo, ſince *all* are concerned in Adam's ſin, *all* muſt likewiſe be concerned in the death of Chriſt. To this we may add, that *all* men are commanded and required to believe that Chriſt died for their ſins; but no man can be obliged to believe what is not true: he muſt therefore have died for *all*. The following paſſages expreſs clearly the univerſality of the object of Chriſt's death. *If any man ſin, we have an advocate with the Father, Jeſus Chriſt the righteous: and he is the propitiation for our ſins: and not for ours only, but alſo for the ſins of the whole world*, (1 Jo. ii. 1, 2.) *The love of Chriſt conſtraineth us; becauſe we thus judge, that if one died for all, then were all dead: and that he died for all, that they which live*

ſhould

Predeſtination.

ſhould not henceforth live unto themſelves, (2 Cor. v. 14.) *God ſo loved the world that he gave his only begotten Son, that whoſoever believeth in him might not periſh, but might have everlaſting life*, (Jo. iii. 16.)

25 Freedom eſſential to moral agents.

But a proper attention to the nature of man will ſet the juſtice of our argument in a ſtill ſtronger point of view. It is obvious, that ſuch an inward freedom as renders a man the maſter of his own conduct, and able to do or not do what he pleaſes, is ſo neceſſary to the morality of our actions, that without it they are neither good nor evil, neither capable of rewards nor puniſhments. Madmen, or men aſleep, are not to be charged with the good or evil of what they do; therefore at leaſt ſome ſmall degree of liberty muſt be left us, otherwiſe why are we praiſed or blamed for our conduct? All virtue and religion, all diſcipline and induſtry, ariſe out of this as their firſt principle, that there is a power in us to govern our own thoughts and actions, and to raiſe and improve our faculties. If this is denied, all efforts, all education, all attention beſtowed upon ourſelves or others, become fruitleſs and vain. If a man accounts himſelf under an inevitable decree, as he will have little remorſe for the evil he does while he imputes it to that inevitable force that conſtrains him, ſo he will naturally conclude that it is to no purpoſe for him to ſtruggle with impoſſibilities. Men are ſufficiently inclined to throw all cenſure off from themſelves, and to indulge in indolence; and upon the doctrine of abſolute predeſtination who can blame them, ſeeing that their efforts can be of no value?

Matter is inactive of itſelf, and only moves in conſequence of its being acted upon by ſome other being. Man is poſſeſſed of a power to begin motion, and to determine it in any direction that he may judge proper. This power and this intelligence conſtitute his liberty,

26 Liberty or neceſſity a queſtion of fact.

and form that image of God that is ſtamped upon his nature. Whether man poſſeſſes this power of acting originally and of himſelf, or whether he is incapable of forming any reſolution, or making any effort, without being acted upon by a foreign cauſe, is not a point to be reaſoned on or diſputed about: it is a queſtion of fact, which, as far as it can poſſibly be known, every man has it in his power to determine by the evidence of his own conſciouſneſs. We do aver, then, that every man is conſcious that he is a free agent, and that it is not poſſible for the moſt ſtaunch predeſtinarian that has ever yet appeared ſeriouſly and practically to convince himſelf of the contrary. It is not poſſible for a man in his ſenſes to believe, that in all thoſe crimes which men charge *themſelves* with, and reproach *themſelves* for, God is the agent; and that, properly ſpeaking, they are no more agents than a ſword is when employed to commit murder. We do indeed, on ſome occaſions, feel ourſelves hurried on ſo impetuouſly by violent paſſions, that we ſeem for an inſtant to have loſt our freedom; but on cool reflection we find, that we both might and ought to have reſtrained that heat in its firſt commencement. We feel that we can divert our thoughts, and overcome ourſelves in moſt inſtances, if we ſet ſeriouſly about it. We feel that knowledge, reflection, and proper ſociety, improve the temper and diſpoſition; and that ignorance, negligence, and the ſociety of the worthleſs and abandoned, corrupt and degrade the mind. From all this we conclude, that man is free, and not under inevitable fate, or irreſiſtible motions to good or evil. This concluſion is confirmed by the whole ſtyle of ſcripture, which upon any other ſuppoſition becomes a ſolemn and unworthy mockery. It is full of perſuaſions, exhortations, reproofs, expoſtulations, encouragements, and terrors. But to what purpoſe is it to ſpeak to dead men, to perſuade the blind to ſee, or the lame to run? If we are under impotence till the irreſiſtible grace comes, and if, when it comes, nothing can withſtand it, what occaſion is there for theſe ſolemn diſcourſes which can have no effect? They cannot render us inexcuſable, unleſs it were in our power to be improved by them; and to imagine that God gives light and bleſſings, which can do no good, to thoſe whom he before intended to damn, only to make them more inexcuſable, and for the purpoſe of aggravating their condemnation, gives ſo ſtrange an idea of his character as it is not fit to expreſs in the language that naturally ariſes out of it. Predeſtination.

27 Some of the acts of God depend on the conduct of his creatures.

Our antagoniſts ſeem to have formed ideas of the divine perfection and ſovereignty that are altogether falſe. There is no imperfection implied in the ſuppoſition that ſome of the acts of God may depend upon the conduct of his creatures. Perfection conſiſts in forming the wiſeſt deſigns, and in executing them by the moſt ſuitable means. The author of nature conducts the planets in their orbits with immutable preciſion according to fixed rules: but it would be abſurd to pretend to manage free agents, or their affairs, in the ſame manner by mathematical or mechanical principles. The providence that is exerted over material objects is fixed and ſteady in its operations, becauſe it is fit that material objects which cannot move of themſelves ſhould be moved in a regular manner: but free and intelligent beings enjoy a wider range, and ought not to be confined to a preſcribed train of exertions; it may therefore be neceſſary that the providence which ſuperintends them ſhould accommodate itſelf to circumſtances. This, however, is not injurious to the divine ſovereignty; for God himſelf is the author of that freedom of agency which he is pleaſed to watch over. He is not leſs the Lord of the univerſe; and ſurely his wiſdom and benevolence are more conſpicuous when he brings good out of evil, and renders the perverſe wanderings of the human heart ſubſervient to purpoſes of mercy, than when he hurls into the immenſity of ſpace the moſt enormous maſs of dead and paſſive matter ſubjected to unerring laws.

28 The inequalities of Providence accounted for.

As for the inequalities of moral ſituation that are to be obſerved in the world, and the giving to ſome nations and perſons the means of improvement, and the denying them to others, the ſcriptures do indeed aſcribe theſe wholly to the riches and freedom of God's grace. And, we confeſs, that the ways of Providence are often dark and myſterious. In this world there are many things which are hard to be underſtood, and many which appear altogether unaccountable; we ſee the wicked man proſpering in his wickedneſs, though it impoſe miſery upon thouſands; we ſee truth hiding its head, and the world governed by fraud and abſurdity. Still, however, we can venture to aſſert, that God beſtows upon all what is neceſſary to enable them to fulfil the obligations expected from the ſtate in which they are placed; and it is elſewhere ſhown, that phyſical evil is among men the parent of moral good. (See PROVIDENCE). God winketh at the times of ignorance;

much

Predeſtination. much is required of them to whom much is given; and it ſhall be more tolerable in the day of judgment for the inhabitants of Sodom and Gomorrah than for the enlightened cities of Galilee. Thus God will be juſt when he judges; none will meet with condemnation excepting thoſe who are inexcuſable. For although he grants more to ſome than may be abſolutely neceſſary, yet he grants leſs to none; and where he grants little, he will ſuit his judgments to the little which he gave. There is no injuſtice in this. If it was the intention of the great Creator that his creation ſhould contain within its ample boſom every poſſible variety of intelligent natures, it was neceſſary that there ſhould be ſomewhere ſuch a being as man; and, in forming all poſſible varieties of human minds and ſituations, it was neceſſary that every particular individual ſhould exiſt. Hence a man may as well complain that he was not formed one of the flaming ſeraphims that ſurround the throne of the Eternal, as that he is not placed in other circumſtances in life than thoſe which he now occupies; for if little is given, little will be required from him. Thus the deſigns of Providence go on according to the goodneſs and mercy of God. None can complain, though ſome have more cauſe for joy than others. What happens to individuals may happen to nations in a body; ſome may have higher privileges, and be placed in happier circumſtances than others; but none can complain of the wiſe and juſt diſpoſer of all, who has given enough, although we may have good reaſon to complain of ourſelves, for not uſing what was ſufficient.

As to the caſe of thoſe who are not bleſſed with the light of the goſpel, we may conſider, that if they have fewer and leſs advantages than others, their nature and capacities muſt likewiſe be inferior; to which their future ſtate may be proportioned. God is not obliged to make all men equally perfect in the next world any more than in this; and if their capacity be rendered leſs than that of an ordinary *Chriſtian*, a lower degree of happineſs may fill it. However, we need not be extremely ſolicitous about their ſtate, much leſs caſt any ungrateful imputations on the Governor of the world for not having dealt ſo bountifully with them as he has with ourſelves; ſince we know that Chriſt died for the whole race of mankind; that every one will at length be 'accepted according to that he has, and not according to that he has not; and that to whomſoever much is given, of him ſhall much be required (B).

29 Scriptural expreſſions explained. Upon theſe principles, we can eaſily explain all the paſſages in the New Teſtament concerning the *purpoſe*, the *election*, the *foreknowledge*, and the *predeſtination* of God. They relate to the deſign of calling the Gentile world to the knowledge of the Meſſias: This was kept ſecret, though hints had been given of it by ſeveral of the prophets, ſo that it was a myſtery; but it was revealed when the apoſtles, in conſequence of Chriſt's commiſſion, *to go and teach all nations*, went about preaching the goſpel to the Gentiles. This was a ſtumbling-block to the Jews, and it was the chief ſubject of diſpute betwixt them and the apoſtles at the time when the Epiſtles were written: ſo that it was neceſſary for them to clear up this point very fully, and to mention it frequently. But in the beginning of Chriſtianity there was no need of amuſing men with high and unſearchable ſpeculations concerning the decrees of God; the apoſtles therefore take up the point in diſpute, the calling of the Gentiles in a general manner. They ſhow, that Abraham at firſt, and Iſaac and Jacob afterwards, were choſen by a diſcriminating favour, that they and their poſterity ſhould be in covenant with God; but that, nevertheleſs, it always was the intention of Providence to call in the Gentiles, tho' it was not executed till theſe later times. Predeſtination.

With this key we can explain coherently the whole of St Paul's diſcourſes upon this ſubject, without aſſerting antecedent and ſpecial decrees as to particular perſons. Things that happen under a permiſſive and directing Providence, may, by a largeneſs of expreſſion, be aſcribed to the will and counſel of God; for a permiſſive will is really a will, though it is not the agent or cauſe of the effect. The *hardening of Pharaoh's heart* may be aſcribed to God, though it is ſaid that his *heart hardened itſelf*, becauſe he took advantage of the reſpites which God granted him from the plagues, to encourage himſelf to longer reſiſtance. Beſides this, he was a cruel and bloody tyrant, and deſerved ſuch judgments for his other ſins; ſo that he may be conſidered as at that time under final condemnation, and only preſerved from the firſt plagues, to afford a ſtriking inſtance of the avenging juſtice of God. That this is the meaning of the paſſage, appears extremely probable from the manner in which Exod. ix. 16. is rendered in the Vatican and Aldus's edit. of the LXX. Inſtead of ſaying, as in our tranſlation, "And in very deed for this cauſe have I *raiſed thee up*, for to ſhow in thee my power, &c." God is repreſented in that verſion as ſaying, "And in very deed for this cauſe have I *kept thee alive till now*, for to ſhow," &c. *Whom he will he hardeneth*, is an expreſſion that can only be applied to ſuch perſons as this tyrant was. It is obvious that the words of our Saviour concerning thoſe *whom his Father had given him*, are only meant of a diſpenſation of Providence, and not of a decree; ſince he adds, And *I have loſt none of them except the ſon of perdition:* for it cannot be ſaid that *Judas Iſcariot* was in the decree, and yet was loſt. And in the ſame paſſage in which God is ſaid *to work in us both to will and to do*, we are required *to work out our own ſalvation with fear and trembling*. The word *ordained* to eternal life alſo ſignifies fitted and diſpoſed to eternal life. The queſtion, *Who made thee to differ?* (1 Cor. iv. 7.) refers to thoſe extraordinary gifts which, in different degrees and meaſures, were beſtowed upon the firſt Chriſtians, in which they were unqueſtionably paſſive.

30 Grace not irreſiſtible. If the decrees of God are not abſolute, neither can his grace be ſo efficacious as abſolutely and neceſſarily to determine our conduct, elſe why are we required *not to grieve God's ſpirit?* why is it ſaid, *ye do always reſiſt the Holy Ghoſt; as your fathers did, ſo do ye? How often*

(B) See Biſhop Law's *Conſiderations on the Theory of Religion*, where this queſtion is treated in a very maſterly manner. The work, though leſs known than it ought to be, has great merit, and of the author we have given a biographical ſketch in our ninth volume.

Predeſtination. *often would I have gathered you under my wings, and ye would not? What could I have done in my vineyard that has not been done in it?* Theſe expreſſions indicate a power in us, by which we not only can, but often do, reſiſt the motions of grace. But if the determining efficacy of grace is not acknowledged, it will be much harder to believe that we are efficaciouſly determined to ſin. This ſuppoſition is ſo contrary both to the holineſs of God, and to the whole ſtyle of the ſacred writings, that it is unneceſſary to accumulate proofs of it. *O Iſrael, thou haſt deſtroyed thyſelf, but in me is thy help: ye will not come unto me that ye may have life: Why will you die, O houſe of Iſrael?*

31 The greateſt ſaint on earth may fall.

As for perſeverance, we may remark, that the many promiſes made in the ſacred ſcriptures to them that *overcome*, that continue *ſtedfaſt and faithful to the death*, do certainly inſinuate that a man may fall from a good ſtate. The words of the apoſtle to the Hebrews are very clear and pointed: *For it is impoſſible for thoſe who were once enlightened, and have taſted of the heavenly gift, and were made partakers of the Holy Ghoſt, and have taſted the good word of God, and the powers of the world to come, if they ſhall fall away, to renew them again unto repentance* (Heb. vi. 4.) It is alſo ſaid, *The juſt ſhall live by faith: but if he draw* (c) *back, my ſoul ſhall have no pleaſure in him*, (Heb. x. 38.) And it is ſaid by the prophet, *When the righteous turneth away from his righteouſneſs, and committeth iniquity, all his righteouſneſs that he hath done ſhall not be mentioned; in his ſin that he hath ſinned ſhall he die*, (Ezek. viii. 24.) Theſe paſſages, with many others, give us every reaſon to believe that a good man may fall from a good ſtate, as well as that a wicked man may turn from a bad one.

32 All difficulties ſolved at the day of judgement.

We conclude the whole by obſerving, that the only difficulty which attends the queſtion ariſes from the myſterious, and apparently partial and unequal, courſe of the divine government in our preſent ſtate; but there is an important day approaching, when God will condeſcend to remove theſe obſcurities, and to vindicate the ways of his providence to man. On that great day, we are well aſſured, that the queſtion will be decided in our favour; for we know that judgment will be given, not according to any abſolute decree, but according to the deeds which we ourſelves ſhall have freely done in the body, whether they have been good, or whether they have been evil.

Thus have we ſtated, we hope with fairneſs and impartiality, a ſummary of the arguments on both ſides of this long agitated queſtion. We need hardly add, that it is a queſtion involved in conſiderable difficulties.—Milton, who was an eminent philoſopher and divine, as well as the firſt of poets, when he wiſhed to exhibit the fallen angels themſelves as perplexed by queſtions above their comprehenſion, ſet them to diſpute about predeſtination.

> They reaſon'd high, of knowledge, will, and fate,
> Fixed fate, free-will, fore-knowledge abſolute;
> And found no end, in wand'ring mazes loſt.
>
> *Paradiſe Loſt.*

The weak ſide of the Calviniſtic doctrine conſiſts in the impoſſibility of reconciling the abſolute and unconditional decree of reprobation with our ideas of the juſtice and goodneſs of God. The weak ſide of the Arminian ſcheme conſiſts in the difficulty of accounting for the certainty of the divine foreknowledge, upon the ſuppoſition of a contingency of events, or an abſolute freedom of will in man. Predeſtination || Predial. 33 The weak ſide of each doctrine.

To elude the former of theſe difficulties, ſome of the late writers upon philoſophical neceſſity, and Dr Prieſtly is among the number, have given up the doctrine of reprobation, and aſſerted, that this world is only a ſtate of preparation for another, in which all men, of every deſcription and character, ſhall attain to final and everlaſting happineſs, when God *ſhall be all, and in all.*—On the other ſide, ſome of the ſupporters of free agency, and Monteſquieu * is among the number, have been diſpoſed to deny the divine attribute of preſcience. * *Lettres Perſ.*

Whatever may be thought of the practical tendency of the two opinions, there is one remark which we think ourſelves bound in juſtice to make, although it appears to us to be ſomewhat ſingular. It is this, that from the earlieſt ages down to our own days, if we conſider the character of the ancient Stoics, the Jewiſh Eſſenes, the modern Calviniſts, and Janſeniſts, when compared with that of their antagoniſts the Epicureans, the Saducees, Arminians, and the Jeſuits, we ſhall find that they have excelled in no ſmall degree in the practice of the moſt rigid and reſpectable virtues, and have been the higheſt honour of their own ages, and the beſt models for imitation to every age ſucceeding. At the ſame time, it muſt be confeſſed, that their virtues have in general been rendered unamiable by a tinge of gloomy and ſevere auſterity.

So far as the ſpeculative foundation of their principles is conſidered, however, neither party ſeems liable to cenſure in a moral point of view. Each of them wiſhes to ſupport, though in a different manner from the other, the honour of the divine character. The Calviniſts begin their argument with the notion of infinite perfection, independency, and abſolute ſovereignty, and thence deduce their opinions; making every difficulty yield to theſe firſt and leading ideas. Their opponents are more jealous of the reſpect due to the divine attributes of juſtice, truth, holineſs, and mercy, and deduce their ſentiments from the idea which they have formed of theſe. Each party lays down general maxims that are admitted by the other, and both argue plauſibly from their firſt principles. Dr Burnet, whom we have here followed very cloſely, juſtly obſerves †, that "theſe are great grounds for mutual charity and forbearance." 34 Mutual forbearance recommended. † *Expoſition of the 39 Articles.*

PREDETERMINATION, in philoſophy and theology, is that concurrence of God which makes men act, and determines them in all their actions, both good and evil, and is called by the ſchoolmen *phyſical predetermination* or *premotion*. See METAPHYSICS, Part III. Chap. v. and PREDESTINATION.

PREDIAL SLAVES. See *Predial-Slaves*.

PRE-

(c) In our tranſlation we read, "If *any man* draw back," &c.; but the words *any man* are not in the original; and if they do not make nonſenſe of the text, they muſt at leaſt be acknowledged to obſcure its meaning.

Predial || Pre-existence.

Predial-Tithes, are thoſe that are paid of things ariſing and growing from the ground only; as corn, hay, fruit, &c.

PREDICABLE, among logicians, denotes a general quality which may be predicated, or aſſerted of ſeveral things: thus animal is predicable of mankind, beaſts, birds, fiſhes, &c.

PREDICAMENT, among logicians, the ſame with category. See Category and Philosophy.

PREDICATE, in logic, that which, in a propoſition, is affirmed or denied of the ſubject. In theſe propoſitions, *ſnow is white, ink is not white;* whiteneſs is the predicate which is affirmed of ſnow, and denied of ink.

PRE-EMPTION, a privilege anciently allowed the king's purveyor, of having the choice and firſt buying of corn and other proviſions for the king's houſe; but taken away by the ſtatute 19 Car. II.

PREENING, in natural hiſtory, the action of birds cleaning, compoſing, and dreſſing their feathers, to enable them to glide more eaſily through the air. For this purpoſe they have two peculiar glands on their rump, which ſecrete an unctuous matter into a bag that is perforated, out of which the bird occaſionally draws it with its bill.

PRE-EXISTENCE, a priority of being, or the being of one thing before another. Thus a cauſe, if not in time, is yet in nature pre-exiſtent to its effect. Thus God is pre-exiſtent to the univerſe. Thus a human father is pre-exiſtent to his ſon. The Peripatetics, though they maintained the eternity of the world, were likewiſe dogmatical in their opinion, that the univerſe was formed, actuated, and governed, by a ſovereign intelligence. See *Ariſtotle on the Soul*, and our articles Creation and Earth. See alſo the *Philoſophical Eſſays of Dr Iſaac Watts*, and the *Principles of natural and revealed Religion*, by the Chevalier Ramſay, where the ſubject of the world's eternity is diſcuſſed. Mr Hume's ſpeculations alſo, on this abſtruſe and arduous ſubject, had a greater tendency to diſſipate its gloom than that philoſopher himſelf could imagine.

1 The Peripatetics maintained the eternity of the world.

2 Pre-exiſtence of the ſoul taught by Aſiatic ſages.

The pre-exiſtence of the human ſoul to its corporeal vehicle had been from time immemorial a prevailing opinion among the Aſiatic ſages, and from them was perhaps transferred by Pythagoras to the philoſophy of the Greeks; but his metempſychoſis, or tranſmigration of ſouls, is too trivial either to be ſeriouſly propoſed or refuted. Nevertheleſs, from the ſentiments of Socrates concerning the immortality of the ſoul, delivered in his laſt interview with his friends, it is obvious that the tenet of pre-exiſtence was a doctrine of the Platonic ſchool. If at any period of life, ſay theſe philoſophers, you ſhould examine a boy, of how many ideas, of what a number of principles, of what an extent of knowledge, will you find him poſſeſſed: theſe without doubt could neither be ſelf-derived nor recently acquired. With what avidity and promptitude does he attain the knowledge of arts and ſciences, which appear entirely new to him! theſe rapid and ſucceſsful advances in knowledge can only be the effects of reminiſcence, or of a fainter and more indiſtinct ſpecies of recollection. But in all the other operations of memory, we find retroſpective impreſſions attending every object or idea which emerges to her view; nor does ſhe ever ſuggeſt any thought, word, or action, without informing us, in a manner equally clear and evident, that thoſe impreſſions have been made upon our ſenſes, mind, or intellect, on ſome former occaſion. Whoever contemplates her progreſs, will eaſily diſcover, that aſſociation is her moſt faithful and efficacious auxiliary; and that by joining impreſſion with impreſſion, idea with idea, circumſtance with circumſtance, in the order of time, of place, of ſimilarity or diſſimilarity, ſhe is capacitated to accumulate her treaſures and enlarge her province even to an indefinite extent. But when intuitive principles, or ſimple concluſions, are elicited from the puerile underſtanding by a train of eaſy queſtions properly arranged, where is the retroſpective act of memory, by which the boy recogniſes thoſe truths as having formerly been perceived in his mind? Where are the crowds of concomitant, antecedent, or ſubſequent ideas, with which thoſe recollections ought naturally to have been attended? In a word, where is the ſenſe of perſonal identity, which ſeems abſolutely inſeparable from every act of memory? This hypotheſis, therefore, will not ſupport pre-exiſtence. After the Chriſtian religion had been conſiderably diffuſed, and warmly combated by its philoſophical antagoniſts, the ſame doctrine was reſumed and taught at Alexandria, by Platonic proſelytes, not only as a topic conſtituent of their maſter's philoſophy, but as an anſwer to thoſe formidable objections which had been deduced from the doctrine of original ſin, and from the vices which ſtain, and from the calamities which diſturb, human life: hence they ſtrenuouſly aſſerted, that all the human race were either introduced to being prior to Adam, or pre-exiſtent in his perſon; that they were not, therefore, repreſented by our firſt parents, but actually concurred in their crime, and participated their ruin.

Pre-exiſtence. 4 Pre exiſtence taught by Chriſtan Platoniſts.

The followers of Origen, and ſuch as entertained the notion of Pre-adamites *, might argue from the doctrine of pre-exiſtence with ſome degree of plauſibility. For the human beings introduced by them to the theatre of probation had already attained the capacity or dignity of moral agents; as their crime therefore was voluntary, their puniſhment might be juſt. But thoſe who believe the whole human race created in Adam to be only pre-exiſtent in their germs or ſtamina, were even deprived of this miſerable ſubterfuge; for in theſe homunculi we can neither ſuppoſe the moral nor rational conſtitution unfolded. Since, therefore, their degeneracy was not ſpontaneous, neither could their ſufferings be equitable. Should it be ſaid that the evil of original ſin was penal, as it extended to our firſt parents alone, and merely conſequential as felt by their poſterity, it will be admitted that the diſtinction between penal and conſequential evil may be intelligible in human affairs, where other laws, aſſortments, and combinations than thoſe which are ſimply and purely moral, take place. But that a moral government, at one of the moſt cardinal periods of its adminiſtration, ſhould admit gratuitous or conſequential evil, ſeems to us irreconcileable with the attributes and conduct of a wiſe and juſt legiſlator. Conſequential evil, taken as ſuch, is miſery ſuſtained without demerit; and cannot reſult from the procedure of wiſdom, benignity, and juſtice; but muſt flow from neceſſity, from ignorance, from cruelty, or from caprice, as its only poſſible ſources. But even upon the ſuppoſition of thoſe who pretend

* See *Pre-adamites.*

5 But no ſolution of original ſin.

3 Socratic arguments for pre-exiſtence refuted.

6 that

Pre-existence || Prefect.

that man was mature in all his faculties before the commiſſion of original ſin, the objections againſt it will ſtill remain in full force: for it is admitted by all except the Samian ſage, that the conſciouſneſs of perſonal identity which was felt in pre-exiſtence, is obliterated in a ſubſequent ſtate of being.

Now it may be demanded, whether agents thus reſuſcitated for puniſhment have not the ſame right to murmur and complain as if they had been perfectly innocent, and only created for that dreadful cataſtrophe? It is upon this principle alone that the effects of puniſhment can be either exemplary or diſciplinary; for how is it poſſible, that the puniſhment of beings unconſcious of a crime ſhould ever be reconciled either to the juſtice or beneficence of that intention with which their ſufferings are inflicted? Or how can others be ſuppoſed to become wiſe and virtuous by the example of thoſe who are neither acquainted with the origin nor the tendency of their miſeries, but have every reaſon to think themſelves afflicted merely for the ſake of afflicting? To us it ſeems clear, that the nature and *rationale* of original ſin lie inſcrutably retired in the boſom of Providence; nor can we, without unpardonable preſumption and arrogance, form the moſt ſimple concluſion, or attempt the minuteſt diſcovery, either different from or extraneous to the clear and obvious ſenſe of revelation. This ſenſe indeed may with propriety be extracted from the whole, or from one paſſage collated with another; but independent of it, as reaſon has no premiſſes, ſhe can form no deductions. The boldneſs and temerity of philoſophy, not ſatisfied with contemplating pre-exiſtence as merely relative to human nature, has dared to try how far it was compatible with the glorious Perſons of the ſacred Trinity. The Arians, who allowed the ſubordinate divinity of our Saviour, believed him pre-exiſtent to all time, and before all worlds; but the Socinians, who eſteemed his nature as well as his perſon merely human, inſiſted, that before his incarnation he was only pre-exiſtent in the divine idea, not in nature or perſon. But when it is conſidered, that children do not begin to deduce inſtructions from nature and experience, at a period ſo late as we are apt to imagine; when it is admitted, that their progreſs, though inſenſible, may be much more rapid than we apprehend; when the opportunities of ſenſe, the ardour of curioſity, the avidity of memory, and the activity of underſtanding, are remarked—we need not have recourſe to a pre-exiſtent ſtate for our account of the knowledge which young minds diſcover. It may likewiſe be added, that moral agents can only be improved and cultivated by moral diſcipline. Such effects therefore of any ſtate, whether happy or miſerable, as are merely mechanical, may be noxious or ſalutary to the patient, but can never enter into any moral economy as parts of its own adminiſtration. Pre-exiſtence, therefore, whether rewarded or puniſhed, without the continued impreſſion of perſonal identity, affords no ſolution of original ſin.

PREFACE, ſomething introductory to a book, to inform the reader of the deſign, method, &c. obſerved therein, and generally whatever is neceſſary to the underſtanding of a book.

PREFECT, in ancient Rome, one of the chief magiſtrates who governed in the abſence of the kings, conſuls, and emperors.

This power was greateſt under the emperors. His chief care was the government of the city, taking cognizance of all crimes committed therein and within 100 miles. He judged capitally and finally, and even preſided in the ſenate. He had the ſuperintendance of the proviſions, building, and navigation. Prefect || Prehnite.

The prefect of modern Rome differs little from the ancient *præfectus*, his authority only extending to 40 miles round the city.

Prefect of the Prætorium, the leader of the pretorian bands deſtined for the emperor's guards, conſiſting, according to Dion, of 10,000 men. This officer, according to Suetonius, was inſtituted by Auguſtus, and uſually taken from among the knights.

By the favour of the emperors his power grew very conſiderable; to reduce which, Conſtantine divided the prefecture of the prætorium into four prefectures, and each of theſe again he ſubdivided into civil and military departments, though the name was only reſerved to him who was inveſted with the civil authority, and that of *comes belli* given him who commanded the cohorts.

PREGADI, in hiſtory, a denomination given to the ſenate of Venice, in which reſides the whole authority of the republic. At its firſt inſtitution it was compoſed of 60 ſenators, to whom 60 more have been added. See VENICE.

PREGNANCY, the ſtate of a woman who has conceived, or is with child. See MIDWIFERY.

PREHNITE, a ſtone ſo named by Mr Werner, inſpector of the mines of Freyburg, brought by Colonel Prehn from the Cape of Good Hope. In the firſt volume of *Chemical Annals* there is a chemical analyſis of this ſtone extracted from the *Acta Naturæ Curioſorum*, Berlin, tom. viii. p. 211. an. 1788, part 2. by Klaproth; from which it appears, that 100 parts of prehnite contain

Silice	$43\frac{5}{6}$ grains.
Alumine	$30\frac{1}{3}$
Lime	$18\frac{1}{3}$
Oxyd of iron	$5\frac{2}{3}$
Water and air	$1\frac{1}{6}$
Total	100

Colonel Prehn gave it the name of emerald, and Mr Bruckmann adopted that denomination, but changed his opinion on conſidering that it had neither the hardneſs, the bright green colour, nor the property of cryſtallizing in hexagonal priſms like the emerald. The Dutch dealers call it *chryſopraſus* of the Cape; but chryſopraſus is nothing but quartz tinged green by the oxyd of nickel. Profeſſor Haquet, in the 4th volume of the Berlin Tranſactions, has named it *cryſtallized praſus*. In the 8th volume, however, Mr Bruckmann conſiders it as a cryſtallized felt-ſpar. Mr Sage calls it *chryſolite*. Mr Rone de l'Iſle claſſes it among the ſchoerls. To this claſſification Mr Klaproth objects, and is rather diſpoſed with Mr Werner to conſider it as a zeolite; on the whole, he thinks it may be conveniently ranked between zeolite and ſchoerl. Mr Haſſenfratz publiſhed in the *Journal de Phyſique* for February 1788 an analyſis of the ſame ſtone, under the title of *Pierre Silice, calcaire, alumineuſe, &c. &c. de couleur verte, &c.* And according to his reſults, which are ſomewhat different from thoſe of Mr Klaproth, and obtained by a different proceſs, it contains, ſilice 50, lime 23.4, alumine 20.4, oxyd of iron 4.9, water 0.9, magneſia 0.5 = 100. The ſpecific gravity of this ſtone, according to the experiments of Mr Briſſon, is 2.9423. The diſſection of its cryſtals, made by Abbé Haüy and Mr Haſſenfratz, diſcovered

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one angle of 60 degrees, as in ſchoerls; but it has hitherto been impoſſible to determine the others. The Abbé Haüy has convinced himſelf, that it bears no reſemblance to zeolite in its cryſtals. This ſtone ſcratches glaſs, and is itſelf ſcratched by rock cryſtal.

1 Definition.

PREJUDICE, or PREJUDGMENT, from *præ* and *judicium*, means a judgment formed beforehand, without examination; the prepoſition *præ* expreſſing an anticipation, not ſo much of time as of knowledge and due attention: hence the ſchoolmen have called it *anticipation and a preconceived opinion*.

2 Origin of prejudice

Prejudice ariſes from the aſſociating principle, which we have explained at large in another article (ſee METAPHYSICS, Part I. chap. 5.), and it is a weakneſs from which no human mind can be wholly free. Some are indeed much more than others under its influence; but there is no man who does not occaſionally act upon principles, the propriety of which he never inveſtigated; or who does not hold ſpeculative opinions, into the truth of which he never ſeriouſly inquired. Our parents and tutors, yea our very nurſes, determine a multitude of our ſentiments: our friends, our neighbours, the cuſtom of the country where we dwell, and the eſtabliſhed opinions of mankind, form our belief; the great, the pious, the learned, and the ancient, the king, the prieſt, and the philoſopher, are characters of mighty efficacy to perſuade us to regulate our conduct by their practice, and to receive as truth whatever they may dictate.

The caſe cannot indeed be otherwiſe. The occaſions of acting are ſo frequent, and the principles of action are ſo various, that were a man to inveſtigate accurately the value of every ſingle motive which preſents itſelf to his mind, and to balance them fairly againſt each other, the time of acting would in moſt inſtances paſs away long before he could determine what ought to be done; and life would be waſted in uſeleſs ſpeculation. The great laws of religion and morality, which ought to be the general and leading principles of action, no man of ſcience will take upon truſt; but in the courſe of a buſy life a thouſand circumſtances will occur in which we muſt act with ſuch rapidity, that, after being ſatisfied of the lawfulneſs of what we are about to do, we muſt, for the prudence of it, confide entirely in the general cuſtoms of our country, or in the practice of other individuals placed in circumſtances ſimilar to ours. In all ſuch caſes, though we may act properly, we act from *prejudice*.

3 Its extenſive dominion.

But the dominion of prejudice is not confined to the actions of the man of buſineſs: it extends over the ſpeculations of the philoſopher himſelf, one half of whoſe knowledge reſts upon no other foundation. All human ſciences are related to each other (ſee PHILOSOPHY, n° 2.), and there is hardly one of them in which a man can become eminent unleſs he has ſome general acquaintance with the whole circle; but no man could ever yet inveſtigate for himſelf all thoſe propoſitions which conſtitute the circle of the ſciences, or even comprehend the evidence upon which they reſt, though he admits them perhaps as truths incontrovertible. He muſt therefore receive many of them upon the authority of others, or, which is the ſame thing, admit them by *prejudice*.

To this reaſoning it may be objected, that when a man admits as true abſtract propoſitions, which, though not ſelf-evident, he cannot demonſtrate, he admits them not by prejudice, but upon teſtimony, which has been elſewhere ſhown to be a ſufficient foundation for human belief (ſee METAPHYSICS, n° 138.) The objection is plauſible, but it is not ſolid; for teſtimony *commands* belief only concerning *events* which, falling under the cognizance of the ſenſes, preclude all poſſibility of miſtake; whereas abſtract propoſitions, not ſelf-evident, can be proved true only by a *proceſs of reaſoning* or by a *ſeries of experiments*; and in conducting both theſe, the moſt vigorous mind is liable to miſtake. When Sir Iſaac Newton told the world that it was the fall of an apple which firſt ſuggeſted to him the general law of gravitation, he bore teſtimony to a fact concerning which he could not be miſtaken; and we receive his teſtimony for the reaſons aſſigned in the article referred to. When he lays down the method of obtaining the fluxion or momentum of the rectangle or product of two indeterminate quantities, which is the main point in his doctrine of fluxions, he labours to eſtabliſh that method on the baſis of demonſtration; and whoever makes uſe of it in practice, without underſtanding that demonſtration, receives the whole doctrine of the modern geometrical analyſis, not as a matter of *fact* upon the credit of Sir Iſaac's *teſtimony*, but as a ſyſtem of abſtract *truth* on the credit of his *underſtanding*: in other words, he is a fluxioniſt by *prejudice*.

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In vain will it be ſaid, that in mathematical demonſtration there is no room for miſtake; and that therefore the man who implicitly adopts the method of fluxions may be conſidered as relying upon the *veracity* of its author, who had no inducement to deceive him, and whoſe comprehenſion was confeſſedly greater than his. In fluxionary mathematics, which treat of matters of which it is extremely difficult, if not impoſſible, to have adequate and ſteady conceptions, the moſt comprehenſive mind is liable to miſtake: and it is well known that the celebrated biſhop of Cloyne wrote his *Analyſt* to prove that the incomparable author of the method of fluxions had committed *two miſtakes* in his fundamental propoſition, which balancing one another, produced a true concluſion by falſe reaſoning. One or other of theſe great men, of whom the leaſt was an eminent mathematician, muſt have been bewildered in his reaſoning, and have fallen into error; and therefore whoever follows either of them implicitly without perceiving the error of the other, is unqueſtionably under the influence of prejudice. This is the caſe with the writer of the preſent article. He perceives not the error of Biſhop Berkeley's reaſoning, and yet he admits the doctrine of fluxions on the authority of Sir Iſaac's demonſtration. That demonſtration, however, he pretends not to underſtand; and therefore he admits the doctrine through *prejudice*.

4 Impoſſible to eradicate all prejudices from the mind;

We have made theſe obſervations to point out the abſurdity of the faſhionable cry againſt the harbouring of any prejudices. To eradicate all prejudices from the human mind is impoſſible; and if it were poſſible, it would be very unwiſe: for we ſee that prejudice may exiſt on the ſide of truth as well as on that of falſehood; and that principles profeſſed and believed by any individual may be uſeful and true, though he was brought to them not by a train of fair and candid reaſoning, but through the medium of prepoſſeſſion or authority. Indeed ſuch is our nature, and ſuch are the laws of aſ-

ſociation,

Prejudice. sociation, that many of our beſt principles, and our obligation to perform many of the moſt amiable of our duties in common life, muſt evidently be acquired in this way. From endearing aſſociations, and authoritative inſtruction, we acquire a knowledge of our duty to our parents, and a facility in performing it, together with the firſt principles of religion, without a ſingle effort of our own reaſon. Even when reaſon has begun to aſſert its power, and ſhows us the propriety of ſuch duties, we are wonderfully aſſiſted in performing them by the amiable prejudices which we had before acquired, and which now appear to be natural to us. He who has never had the advantage of ſuch aſſociations, and who acquires a knowledge of the duties ſuggeſted by them after he has come to years of diſcretion, and chiefly by the efforts of his own reaſon, will ſeldom, *cæteris paribus*, perform thoſe duties with an energy and delight equal to that of the perſon who has. This remark appears to be confirmed by experience; for it is often found, that the children of the great, who have been given out to nurſe in their infancy, and who have ſeldom been in the company of their parents till their reaſoning faculties have been far advanced, are much leſs dutiful and affectionate than thoſe in the middle or lower ſtations of life, who have ſcarcely ever been out of their parents company.

5 Which would not be wiſe if it were poſſible.

Would it then be wiſe, even if it were practicable, to diſſolve all thoſe aſſociations which tend ſo powerfully to increaſe the mutual affections of parents and children? We cannot think that it would; as we believe it might be eaſily ſhown that public ſpirit ſprings out of private affection. Plato indeed held an opinion very different from ours; for in order to extend that affection which is uſually laviſhed at home to the whole ſtate, he propoſed that children ſhould be educated at the public expence, and never be permitted to know the authors of their being. But this is only one of the many viſionary projects of that great man, of which daily experience ſhows the abſurdity. In modern times, we are certain that leſs dependence is to be had upon the *patriotiſm* of the man who, for the love which he pretends to his country, can overlook or forget his own partial connections in it, than on him who, at the ſame time that he wiſhes his country well, is feelingly alive to all the endearments of kindred affection.

Such affection may be called *partial*, and very probably has its foundation in that which is the ſource of all our prejudices: but if it be properly trained in early life, it will gradually extend from our neareſt relations to the perſons with whom we aſſociate, and to the place which not only gave us birth, but alſo furniſhed our youthful and moſt innocent enjoyments. It is thus that the *amor patriæ* is generated (ſee PASSION and PATRIOTISM), which in minds unſeduced by falſe principles is exceedingly ſtrong; and though a partial affection, is of the moſt general utility. It is this prejudice which reconciles the Laplander to his freezing ſnows, and the African to his burning ſun; which attaches the native of the Highlands or of Wales as much to his mountains and rocks, as the apparently happier inhabitant of the ſouthern counties of England is to the more fertile and delightful ſpot where he drew his firſt breath. And we find in fact, that when a native of Kent and a Scotch Highlander have in ſome diſtant corner of the world gained a competent fortune without being corrupted by luxury, they return, the one to his hop-gardens, and the other to his mountains. Were this prejudice, for ſuch it ſurely is, wholly eradicated from the human mind, it is obvious that large tracts of country which are now full of inhabitants would be totally deſerted; and that the hungry barbarians, to make room for themſelves, would exterminate the proprietors of more favourable climes. From an affection to our friends and to our country, we naturally contract an affection for that mode of government under which we live; and unleſs it be particularly oppreſſive to ourſelves or any order of citizens, we come as naturally to prefer it to all other modes, whether it deſerve that preference or not. This no doubt is prejudice, but it is a beneficial prejudice; for were the multitude, who are wholly incapable of eſtimating the excellencies and defects of the various modes of government, to become diſſatisfied with their own, and riſe in a maſs to change it for the better, the moſt horrible conſequences might juſtly be dreaded. Of this truth the preſent ſtate of Europe affords too melancholy and convincing a proof. The man therefore who, under the pretence of enlightening the public mind and extirpating prejudices, paints to the illiterate vulgar, in aggravated colours, the abuſe of that government which has hitherto protected them from the ferocity of each other, is one of the greateſt criminals if his views be ſelfiſh, and one of the worſt reaſoners if they be diſintereſted, that human imagination can eaſily conceive.

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7 Danger of improper attempts to remove them.

With the ſelfiſh patriot we have at preſent no concern; but we may with propriety aſk the diſintereſted lover of truth, whether he thinks it poſſible, that in a large community, of which nine-tenths of the members are neceſſarily incapable of taking comprehenſive views of things, or feeling the force of political reaſonings, any form of government can be acceptable to the people at large, which does not gain their affections through the medium of prejudice? It has been ſhown by Mr Hume with great ſtrength of argument, that government is founded on *opinion*, which is of two kinds, viz. opinion of intereſt, and opinion of right. By opinion of intereſt, he underſtands the ſenſe of the general advantage which is reaped from government, together with the perſuaſion that the particular government which is eſtabliſhed is equally advantageous with any other that could eaſily be ſettled. The opinion entertained of the *right* of any government is always founded in its antiquity; and hence ariſes the paſſionate regard which under ancient monarchies the people have for the true heir of their royal family. Theſe opinions, as held by the philoſopher converſant with the hiſtory of nations, are founded upon reaſoning more or leſs concluſive; but it is obvious, that in the minds of the multitude they can have no other foundation than prejudice. An illiterate clown or mechanic does not *ſee how* one form of government promotes the general intereſt more than another; but he may *believe* that it does, upon no other evidence than the declamation of a demagogue, who, for ſelfiſh purpoſes, contrives to flatter his pride. The ſame is the caſe with reſpect to the rights of hereditary monarchy. The anatomiſt finds nothing more in the greateſt monarch than in the meaneſt peaſant, and the moraliſt may perhaps frequently find leſs; but the true philoſopher acknowledges his right to the ſovereignty: and though he be weak in underſtanding, or infirm in years, would, for

8 Good effects of ſome prejudices.

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the ſake of public peace and the ſtability of government, maintain him in his throne againſt every competitor of the moſt ſhining talents. The vulgar, however, who would act with this philoſopher, are influenced by no ſuch views, but merely by their prejudices in favour of birth and family; and therefore it is ridiculous to think of changing the public mind with reſpect to any form of government by pure reaſoning. In France a total change in the minds of the people has indeed been effected, and from the moſt violent prejudices in favour of royalty, they have now become more violently prejudiced in favour of republicaniſm. Bad as their government unqueſtionably was, the change that has now taken place is not the effect of calm reaſoning and accurate inquiry (for of that the bulk of mankind appears to be incapable), nor are their prejudices leſs violent than they were before. They are changed indeed; but no one will deny that prejudice, and that of the moſt violent kind, leads them on at preſent; nor can any one aſſert that their new prejudices have rendered them more happy, or their country more flouriſhing, than their former ones, which made them cry *Vive le Roi* under the tyrannic government of Louis XIV.

The influence of prejudice is not more powerful in fixing the political opinions of men, than in dictating their religious creed. Every child of a religious father receives his faith by inheritance long before he be capable of judging whether it be agreeable or diſagreeable to the word of God and the light of reaſon. This experience ſhows to be the fact; and found philoſophy declares that it cannot be otherwiſe. Parents are appointed to judge for their children in their younger years, and to inſtruct them in what they ſhould believe, and what they ſhould practiſe in the civil and religious life. This is a dictate of nature, and doubtleſs would have been ſo in a ſtate of perfect innocence. It is impoſſible that children ſhould be capable of judging for themſelves before their minds are furniſhed with a competent number of ideas, and before they are acquainted with any *principles* and *rules* of juſt reaſoning; and therefore they can do nothing better than run to their parents, and receive their directions what they ſhould believe and what they ſhould practiſe.

This mode of tutoring the infant mind, and giving to our inſtructions the force of prejudice, before reaſon can operate with much effect, will, we know, be highly diſpleaſing to many who challenge to themſelves alone the epithet of liberal. With them it will be cramping the genius and perverting the judgment: but we cannot help thinking that ſuch an objection, if it ſhould be made, would be the offſpring of ignorance; for it requires but very little knowledge of human nature to be able to ſee, that if children be not reſtrained by authority, and if we do not inſinuate a love of good principles into their minds, bad ones will inſinuate themſelves, and a little time will give *them* the force of inveterate prejudice, which all the future efforts of reaſon and philoſophy will find it difficult to eradicate. The idea of keeping a child ignorant of the being of a God, and the grand duties of morality and religion, till he ſhall come to years of diſcretion, and then allowing him to reaſon them out for himſelf, is an abſurd chimera: it is an experiment which never has been tried, which to us it appears impoſſible to try, and which, if it could be tried, could not poſſibly produce any good effect. For ſuppoſe we had a youth juſt arrived at years of diſcretion, totally ignorant of all theſe things, and unbiaſſed to any ſyſtem of opinions, or rather poſſeſſed of no opinions at all—it would, in the firſt place, we ſuſpect, be abſolutely neceſſary to direct his thoughts into a particular train, and for ſome perſon to lead him on from one idea to another, till he ſhould arrive at ſome concluſion: but in all this there is the influence of authority, aſſociation, and of prejudice.

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9 Origin of bigotry.

It being therefore abſolutely neceſſary that ſentiments of religion be inſtilled into the minds of children before they be capable of diſcovering by the uſe of their reaſon whether thoſe ſentiments be juſt or not, it need not excite wonder, nor is it any reflection upon religion, that moſt men adhere with bigotry to the creed of their fathers, and ſupport that creed by arguments which could carry conviction to no minds but their own. The love and veneration which they bear to the memory of thoſe from whom they imbibed their earlieſt opinions, do not permit them to perceive either the falſehood of thoſe opinions, or their little importance, ſuppoſing them true. Hence the many frivolous diſputes which have been carried on among Chriſtians; and hence the zeal with which ſome of them maintain tenets which are at once contrary to ſcripture, to reaſon, and to common ſenſe. A due reflection, however, on the ſource of all prejudices ought to moderate this zeal; for no man is wholly free from that bias which he is ſo ready to condemn in others: and indeed a man *totally free from prejudice*, would be a more unhappy being than the moſt violent bigot on earth. In ſcience, he would admit nothing which he could not himſelf demonſtrate; in buſineſs, he would be perpetually at a ſtand for want of motives to influence his conduct: he could have no attachment to a particular country; and therefore muſt be without patriotiſm, and without the ſolaces of friendſhip; and his religion, we are afraid, would be cold and lifeleſs.

10 An objection anſwered.

What, it will be ſaid, are the authors of a work which profeſſes to enlighten the public mind by laying before it a general view of ſcience and literature, become at laſt the advocates of *prejudice*, which is the *bane* of *ſcience*, and the *prop* of *ſuperſtition*? No, we are advocates for no prejudice which is either inimical to ſcience or friendly to abſurdity; but we do not think that the moraliſt would act wiſely who ſhould deſert his proper buſineſs to make himſelf maſter of the higher mathematics, merely that he might not be obliged to truſt occaſionally to the demonſtrations of others. The writer of this article is not ſkilled in trade; but it is not his opinion that the merchant would ſoon grow rich, who ſhould never make a bargain till he had previouſly calculated with mathematical exactneſs all the probabilities of his gain or loſs. That to diſſolve all the aſſociations which are the ſource of partial attachments of kindred, affection, and private friendſhip, would tend to promote the public happineſs, we cannot poſſibly believe. And we think, that the experience of the preſent eventful day abundantly confirms Mr Hume's opinion, that far from endeavouring to extirpate the people's prejudices in favour of birth and family, we ſhould cheriſh ſuch ſentiments, as being abſolutely requiſite to preſerve a due ſubordination in ſociety. That men would be better Chriſtians if they were to receive no religious inſtruction till they ſhould be able by their own reaſon to judge of its

8 Abſurdity of keeping children ignorant of religion from the dread of prejudice.

Prejudice. its truth, daily obſervation does not warrant us to conclude; for we ſee thoſe who have ſeldom heard of God when children, "live without him in the world" when they are men.

Pernicious prejudices we have traced to their ſource elſewhere, and ſhown how they may be beſt prevented by proper attention in the education of children. (See METAPHYSICS, n° 98). We ſhall only add here, that the earlier ſuch attention is paid, the more effectual it will be found; and that it is much eaſier to keep prejudices out of the mind than to remove them after they have been admitted. This however muſt be ſometimes attempted; and where prejudices are ſtrong, ſeveral methods have been recommended for rendering the attempt ſucceſsful. The following are taken moſtly from Dr Watts's improvement of the mind.

11 Proper methods of removing prejudices.

1. Never attack the prejudice *directly*, but lead the perſon who is under its influence ſtep by ſtep to the truth. Perhaps your neighbour is under the influence of *ſuperſtition and bigotry in the ſimplicity of his ſoul*; you muſt not immediately run upon him with violence, and ſhow him the abſurdity or folly of his own opinions, though you might be able to ſet them in a glaring light; but you muſt rather begin at a diſtance, and eſtabliſh his aſſent to ſome familiar and eaſy propoſitions, which have a tendency to refute his miſtakes, and to confirm the truth; and then ſilently obſerve what impreſſion this makes upon him, and proceed by ſlow degrees as he is able to bear, and you muſt carry on the work perhaps at diſtant ſeaſons of converſation. The tender or diſeaſed eye cannot bear a deluge of light at once.

Overhaſtineſs and vehemence in arguing is oftentimes the effect of *pride*; it blunts the poignancy of the argument, breaks its force, and diſappoints the end. If you were to convince a perſon of the falſehood of the *doctrine of tranſubſtantiation*, and you take up the conſecrated bread before him and ſay, "You may ſee, and taſte, and feel, *this is nothing but bread*; therefore whilſt you aſſert that God commands you to believe *it is not bread*, you moſt wickedly accuſe God of commanding you to tell a lie." This ſort of language would only raiſe the indignation of the perſon againſt you, inſtead of making any impreſſions upon him. He will not ſo much as think at all on the argument you have brought, but he rages at you as a *profane wretch*, ſetting up your own ſenſe and reaſon above ſacred authority; ſo that though what you affirm is a truth of great evidence, yet you loſe the benefit of your whole argument by an ill management, and the unreaſonable uſe of it.

2. Where the prejudices of mankind cannot be conquered at once, but will riſe up in arms againſt the evidence of truth, there we muſt make ſome allowances, and yield to them for the preſent, as far as we can ſafely do it without real injury to truth; and if we would have any ſucceſs in our endeavours to convince the world, we muſt practiſe this complaiſance for the benefit of mankind. Take a ſtudent who has deeply imbibed the principles of the *Peripatetics*, and imagines certain immaterial beings, called *ſubſtantial forms*, to inhabit every herb, flower, mineral, metal, fire, water, &c. and to be the ſpring of all its properties and operations; or take a Platoniſt, who believes an *anima mundi*, "an univerſal ſoul of the world," to pervade all bodies, to act in and by them according to their nature, and indeed to give them their nature and their ſpecial powers; perhaps it may be very hard to convince theſe perſons by arguments, and conſtrain them to yield up thoſe fancies. Well then, let the one believe his *univerſal ſoul*, and the other go on with his notion of *ſubſtantial forms*, and at the ſame time teach them how by certain original laws of motion, and the various ſizes, ſhapes, and ſituations of the parts of matter, allowing a continued divine concourſe in and with all, the ſeveral appearances in nature may be ſolved, and the variety of effects produced, according to the corpuſcular philoſophy, improved by *Deſcartes*, *Mr Boyle*, and *Sir Iſaac Newton*; and when they have attained a degree of ſkill in this ſcience, they will ſee theſe airy notions of theirs, theſe imaginary powers, to be ſo uſeleſs and unneceſſary, that they will drop them of their own accord. The *Peripatetic forms* will vaniſh from the mind like a dream, and the *Platonic ſoul of the world will expire*. Prejudice.

We may give another inſtance of the ſame practice, where there is a prejudicate fondneſs of particular words and phraſes. Suppoſe a man is educated in an *unhappy form of ſpeech*, whereby he explains ſome *great doctrine of the goſpel*, and by the means of this phraſe he has imbibed a very falſe idea of that doctrine; yet he is ſo bigotted to his form of words, that he imagines if thoſe words are omitted the form is loſt. Now, if we cannot poſſibly perſuade him to part with his improper terms, we will indulge them a little, and try to explain them in a ſcriptural ſenſe, rather than let him go on in his miſtaken ideas. A perſon who has been bred a *Papiſt*, knows but little of religion, yet he reſolves never to part from the *Roman Catholic faith*, and is obſtinately bent againſt a change. Now it cannot be unlawful to teach ſuch an one the true Chriſtian, *i. e.* the *Proteſtant religion*, out of the *Epiſtle to the Romans*, and ſhow him that the ſame doctrine is contained in the *Catholic Epiſtles of St Peter, James, and Jude*, and thus let him live and die a good Chriſtian in the belief of the religion taught him out of the New Teſtament, while he imagines he is a *Roman Catholic* ſtill, becauſe he finds the doctrine he is taught in the *Catholic* Epiſtles and in that to the *Romans* Sometimes we may make uſe of the very prejudices under which a perſon labours, in order to convince him of ſome particular truth, and argue with him upon his own profeſſed principles as though they were true. Suppoſe a *Jew* lies ſick of a fever, and is forbid fleſh by his phyſician; but hearing that rabbits were provided for the dinner of the family, deſired earneſtly to eat of them; and ſuppoſe he became impatient, becauſe his phyſician did not permit him, and he inſiſted upon it that it could do him no hurt—ſurely rather than let him perſiſt in that fancy and that deſire, to the danger of his life, we might tell him that theſe animals were ſtrangled, a ſort of food forbidden by the Jewiſh law, though we ourſelves might believe that law to be aboliſhed.

Where we find any perſon obſtinately perſiſting in a miſtake in oppoſition to all reaſon, eſpecially if the miſtake be very injurious or pernicious, and we know this perſon will hearken to the ſentiment or authority of ſome favourite name; it is needful ſometimes to urge the *opinion and authority* of that favourite perſon, ſince that is likely to be regarded much more than *reaſon*. We are almoſt aſhamed indeed to ſpeak of uſing any *influence of authority* in reaſoning or argument; but in ſome

Prejudice || Premonſtrantes.

cases it is better that poor, ſilly, perverſe, obſtinate creatures, ſhould be perſuaded to judge and act right, by a veneration for the ſenſe of others, than to be left to wander in pernicious errors, and continue deaf to all argument, and blind to all evidence. They are but children of a larger ſize; and ſince they perſiſt all their lives in their minority, and reject all true reaſoning, ſurely we may try to perſuade them to practiſe what is for their own intereſt by ſuch childiſh reaſons as they will hearken to. We may overawe them from purſuing their own ruin by the terrors of a ſolemn ſhadow, or allure them by a ſugar plum to their own happineſs. But after all, we muſt conclude, that whereſoever it can be done, it is beſt to *remove and root out thoſe prejudices* which obſtruct the entrance of truth into the mind, rather than to palliate, humour, or indulge them; and ſometimes this muſt neceſſarily be done, before you can make a perſon part with ſome beloved error, and lead him into better ſentiments.

12 Mutual forbearance recommended.

On the whole, we would recommend more mutual forbearance and leſs acrimony than is commonly found among writers on diſputed ſubjects, as the only means by which our differences in religion, politics, and ſcience, ever can be healed, and truth certainly diſcovered. If men were leſs violent in defending their particular opinions, they would always gain a more patient hearing, they would be leſs ſuſpected of, and leſs liable to, prejudice, and of courſe more apt either to convince or to be convinced. They would likewiſe by ſo doing ſhow, in the moſt unequivocal manner, their attention to ſound philoſophy, and above all to genuine Chriſtianity; which, though it is far from encouraging ſcepticiſm, or a temporizing ſpirit, recommends, in the ſtrongeſt terms, among all its profeſſors, *univerſal charity and mutual forbearance*. See PROBABILITY, TRUTH, and SUPERSTITION.

PRELATE, an eccleſiaſtic raiſed to ſome eminent and ſuperior dignity in the church; as biſhops, archbiſhops, patriarchs, &c.

PRELIMINARY, in general, denotes ſomething to be examined and determined before an affair can be treated of to the purpoſe.

PRELUDE, in muſic, is uſually a flouriſh or irregular air, which a muſician plays off-hand, to try if his inſtrument be in tune, and ſo lead him into the piece to be played.

PREMISSES, in logic, an appellation given to the two firſt propoſitions of a ſyllogiſm. See LOGIC.

PREMISSES, in law, properly ſignifies the land, &c. mentioned in the beginning of a deed.

PREMIUM, or PRÆMIUM, properly ſignifies a reward or recompenſe: but it is chiefly uſed in a mercantile ſenſe for the ſum of money given to an inſurer, whether of ſhips, houſes, lives, &c. See INSURANCE.

PREMNA, in botany; a genus of the angioſpermia order, belonging to the didynamia claſs of plants. The calyx is bilobed; the corolla quadrifid; the berry quadrilocular; the ſeeds ſolitary.

PREMONSTRANTES, or PRÆMONSTRATENSES, a religious order of regular canons inſtituted in 1120, by S. Norbert; and thence alſo called *Norbertines*.

The firſt monaſtery of this order was built by Norbert in the Iſle of France, three leagues to the weſt of Laon; which he called *Præmonſtre*, *Præmonſtratum*, and hence the order itſelf derived its name; though as to the occaſion of that name, the writers of that order are divided. At firſt the religious of this order were ſo very poor, that they had only a ſingle aſs, which ſerved to carry the wood they cut down every morning, and ſent to Laon in order to purchaſe bread. But they ſoon received ſo many donations, and built ſo many monaſteries, that in 30 years after the foundation of the order, they had above 100 abbeys in France and Germany: and in proceſs of time the order ſo increaſed, that it had monaſteries in all parts of Chriſtendom, amounting to 1000 abbeys, 300 provoſtſhips, a vaſt number of priories, and 500 nunneries. But they are now greatly diminiſhed. The rule they followed was that of St Auguſtine, with ſome ſlight alterations, and an addition of certain ſevere laws, whoſe authority did not long ſurvive their founder. Premonſtrantes || Prenotion.

The order was approved by Honorius II. in 1126, and again by ſeveral ſucceeding popes. At firſt the abſtinence from fleſh was rigidly obſerved. In 1245 Innocent IV. complained of its being neglected to a general chapter. In 1288, their general, William, procured leave of pope Nicholas IV. for thoſe of the order to eat fleſh on journeys. In 1460, Pius II. granted them a general permiſſion to eat meat, excepting from Septuageſima to Eaſter. The dreſs of the religious of this order is white, with a ſcapulary before the caſſock. Out of doors they wear a white cloak and white hat; within, a little camail; and at church, a ſurplice, &c.

In the firſt monaſteries built by Norbert, there was one for men and another for women, only ſeparated by a wall. In 1137, by a decree of a general chapter, this practice was prohibited, and the women removed out of thoſe already built, to a greater diſtance from thoſe of the men.

The Præmonſtratenſes, or monks of Premontre, vulgarly called *white canons*, came firſt into England, A. D. 1146. Their firſt monaſtery, called *New-houſe*, was erected in Lincolnſhire, by Peter de Saulia, and dedicated to St Martial. In the reign of Edward I. this order had 27 monaſteries in England.

PRENANTHES, in botany: A genus of the polygamia æqualis order, belonging to the ſyngeneſia claſs of plants; and in the natural method ranking under the 49th order, *Compoſitæ*. The receptacle is naked; the calyx calyculated; the pappus is ſimple, and almoſt ſeſſile; the florets are placed in a ſingle ſeries.

PRENOMEN, PRÆNOMEN, among the ancient Romans, a name prefixed to their family name, and anſwering to our Chriſtian name: ſuch are Caius, Lucius, Marcus, &c.

PRENOTION, PRÆNOTIO, or *Præcognitio*, is a notice or piece of knowledge preceding ſome other in reſpect of time. Such is the knowledge of the antecedent, which muſt precede that of the concluſion. It is uſed by Lord Bacon for breaking of an endleſs ſearch, which he obſerves to be one of the principal parts of the art of memory. For when one endeavours to call any thing to mind, without ſome previous notion or perception of what is ſought for, the mind exerts itſelf and ſtrives in an endleſs manner: but if it hath any ſhort notion before-hand, the infinity of the ſearch is preſently cut off, and the mind hunts nearer home, as in an incloſure. Thus verſe is eaſier remembered than proſe; becauſe if we ſtick at any word in a verſe, we have

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have a previous notion that it is ſuch a word as muſt ſtand in a verſe. Hence alſo, order is a manifeſt help to memory; for here is a previous notion, that the thing ſought for muſt be agreeable to order. Bacon's *Works Abr.* vol. i. p. 136. and vol. ii. p. 473.

PREPARATION, in a general ſenſe, the act of diſpoſing things in ſuch a manner as to render any foreſeen event more advantageous or leſs hurtful according to its nature.

PREPARATION *of Diſſonances*, in muſic, is their diſpoſition in harmony in ſuch a manner, that, by ſomething congenial in what precedes, they may be rendered leſs harſh to the ear than they would be without that precaution: according to this definition, every diſcord ought to be prepared. But when, in order to prepare a diſſonance, it is exacted that the ſound which forms it ſhould before have formed a conſonance, then there is fundamentally but one ſingle diſſonance which is prepared, viz. the ſeventh. Nor is even this preparation neceſſary in the chord which contains the ſenſible note, becauſe then the diſſonance being characteriſtical, both in its chord and in its mode, the ear has ſufficient reaſon to expect it: it accordingly does expect it, and recogniſe it; nor is either deceived with reſpect to its chord nor its natural progreſs. But when the ſeventh is heard upon a fundamental ſound which is not eſſential to the mode, it ought then to be prepared, in order to prevent all ambiguity; to prevent the ear, whilſt liſtening to this note, from loſing its train: and as this chord of the ſeventh may be inverted and combined in ſeveral different manners, from this ariſe likewiſe a number of different ways by which it may ſeem to be prepared, which, in the main, always iſſue however in the ſame thing.

In making uſe of diſſonances, three things are to be conſidered; viz. the chord which precedes the diſſonance, that in which it is found, and that which is immediately ſubſequent to it. Preparation only reſpects the two firſt; for the third, ſee RESOLUTION.

When we would regularly prepare a diſcord in order to arrive at its chord, we muſt chooſe ſuch a career of the fundamental baſs, that the ſound which forms the diſſonance may be a protraction into the perfect time of the ſame note which formed a conſonance formerly ſtruck in the imperfect in the preceding chord; this is what we call *ſincopation*. See SINCOPATION.

From this preparation two advantages reſult; viz. 1. That there is neceſſarily an harmonical connection between the two chords, ſince that connection is formed by the diſſonance itſelf; and, 2. That this diſſonance, as it is nothing elſe but the continuation of the ſame ſound which had formed a conſonance, becomes much leſs harſh to the ear than it would have been with any ſound recently ſtruck. Now this is all that we expect to gain by preparation. See CADENCE, DISCORD, and HARMONY.

By what has been juſt ſaid, it will appear that there is no other part peculiarly deſtined for preparing the diſſonance, except that in which it is heard; ſo that if the treble ſhall exhibit a diſſonance, that muſt be ſincopated; but if the diſſonance is in the baſs, the baſs muſt be ſincopated. Though there is nothing here but what is quite ſimple, yet have maſters of muſic miſerably embroiled the whole matter.

Some diſſonances may be found which are never prepared: ſuch is the ſixth ſuperadded: ſome which are very unfrequently prepared; ſuch is the diminiſhed ſeventh. Preparation

PREPARATIONS, in pharmacy, the medicines when mixed together in ſuch a manner as to be fit for the uſe of the patient. See PHARMACY, Part II.

PREPARATIONS, in anatomy, the parts of animal bodies prepared and preſerved for anatomical uſes.

The manner of preſerving anatomical preparations, is either by drying them thoroughly in the air, or putting them into a proper liquor.

In drying parts which are thick, when the weather is warm, care muſt be taken to prevent putrefaction, fly-blows, inſects, &c. This is eaſily done by the uſe of a ſolution of corroſive ſublimate in ſpirit of wine, in the proportion of two drams of ſublimate to a pound of ſpirit: the part ſhould be moiſtened with this liquor as it dries, and by this method the body of a child may be kept ſafe even in ſummer. Dried preparations are apt to crack and moulder away in keeping; to prevent this, their ſurface ſhould be covered with a thick varniſh, repeated as often as occaſion requires. *Edin. Med. Eſſays*, vol. ii. p. 2.

Though ſeveral parts prepared dry are uſeful, yet others muſt be ſo managed as to be always flexible, and nearer a natural ſtate. The difficulty has been to find a proper liquor for this purpoſe. Dr Monro ſays, the beſt he knows is a well rectified colourleſs ſpirit of wine, to which is added a ſmall quantity of the ſpirit of vitriol or nitre. When theſe are properly mixed, they neither change their colour nor the conſiſtence of the parts, except where there are ſerous or mucous liquors contained in them. The brain, even of a young child, in this mixture grows ſo firm as to admit of gentle handling, as do alſo the vitreous and cryſtalline humours of the eye. The liquor of the ſebaceous glands and the ſemen are coagulated by this ſpirituous mixture; and it heightens the red colour of the injection of the blood-veſſels, ſo that after the part has been in it a little time, ſeveral veſſels appear which were befor inviſible. If you will compare theſe effects with what Ruyſch has ſaid of his balſam, you will find the liquor above-mentioned to come very near to it.

The proportion of the two ſpirits muſt be changed according to the part prepared. For the brain and humours of the eye, you muſt put two drams of ſpirit of nitre to one pound of ſpirit of wine. In preſerving other parts which are harder, 30 or 40 drops of the acid will be ſufficient; a larger quantity will make bones flexible, and even diſſolve them. The part thus preſerved ſhould be always kept covered with the liquor: therefore great care ſhould be taken to ſtop the mouth of the glaſs with a waxed cork and a bladder tied over it, to prevent the evaporation of the ſpirit; ſome of which, notwithſtanding all this care, will fly off; therefore freſh muſt be added as there is occaſion. When the ſpirits change to a dark tincture, which will ſometimes happen, they ſhould be poured off, and freſh put in their room; but with ſomewhat leſs acid than at firſt.

The glaſſes which contain the preparations ſhould be of the fineſt ſort, and pretty thick; for through ſuch the parts may be ſeen very diſtinctly, and of a true colour, and the object will be ſo magnified as to

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ſhow veſſels in the glaſs which out of it were not to be ſeen.

As the glaſs when filled with the liquor has a certain focus, it is neceſſary to keep the preparation at a proper diſtance from the ſides of it, which is eaſily done by little ſticks ſuitably placed, or by ſuſpending it by a thread in a proper ſituation. The operator ſhould be cautious of putting his fingers in this liquor oftener than is abſolutely neceſſary; becauſe it brings on a numbneſs on the ſkin, which makes the fingers unfit for any nice operation. The beſt remedy for this is to waſh them in water mixed with a few drops of oil of tartar per deliquium.

Dr Chriſt. Jac. Trew prefers the rectified ſpirit of grain for preſerving anatomical preparations to ſpirit of wine, or to compoſitions of alcohol, amber, camphor, &c. becauſe theſe ſoon change into a brown colour, whereas the ſpirit from malt preſerves its limpid appearance. When any part is to be preſerved wet, waſh it with water till it is no more tinctured. The water is next to be waſhed away with ſpirits, and then the preparation is to be put among ſpirits in a glaſs, the mouth of which is to be cloſely covered with a glaſs head, over which a wet bladder and leaf-tin are to be tied. *Com. Lit. Norimb.* 1731, *ſemeſt.* 1. *ſpecim.* 9. See alſo *Pole's Anatomical Inſtructor*, and *American Tranſactions*, vol. ii. p. 366.

PREPENSED, in law, denotes fore-thought. In which ſenſe we ſay *prepenſed malice*, &c. If, when a man is ſlain upon a ſudden quarrel, there were malice prepenſed formerly between them, it makes it murder; and, as it is called in ſome ſtatutes, *prepenſed murther*.

PREPOSITION, in grammar, one of the parts of ſpeech, being an indeclinable particle which yet ſerves to govern the nouns that follow it; ſuch as *per*, *pro*, *propter*; and through, for, with, &c.

F. Buffier allows it to be only a modificative of a part of ſpeech, ſerving to circumſtantiate a noun.

PREPUCE, in anatomy, the foreſkin, being a prolongation of the cutis of the penis, covering the glans. See ANATOMY, n° 107.

PREROGATIVE, an excluſive or peculiar privilege.

Royal PREROGATIVE, that ſpecial pre-eminence which the king hath over and above all other perſons, and out of the ordinary courſe of the common law, in right of his regal dignity. It ſignifies in its etymology (from *præ* and *rogo*) ſomething that is required or demanded before, or in preference to, all others. And hence it follows, that it muſt be in its nature ſingular and eccentrical; that it can only be applied to thoſe rights and capacities which the king enjoys alone in contradiſtinction to others, and not to thoſe which he enjoys in common with any of his ſubjects: for if once any one prerogative of the crown could be held in common with the ſubject, it would ceaſe to be prerogative any longer. And therefore Finch lays it down as a maxim, that the prerogative is that law in caſe of the king, which is law in no caſe of the ſubject.

Prerogatives are either *direct* or *incidental*. The *direct* are ſuch poſitive ſubſtantial parts of the royal character and authority, as are rooted in, and ſpring from, the king's political perſon, conſidered merely by itſelf, without reference to any other extrinſic circumſtance; as, the right of ſending ambaſſadors, of creating peers, and of making war or peace. But ſuch prerogatives as are *incidental* bear always a relation to ſomething elſe, diſtinct from the king's perſon; and are indeed only exceptions, in favour of the crown, to thoſe general rules that are eſtabliſhed for the reſt of the community: ſuch as, that no coſts ſhall be recovered againſt the king; that the king can never be a joint tenant; and that his debt ſhall be preferred before a debt to any of his ſubjects. Prerogative.

Theſe ſubſtantive or direct prerogatives may again be divided into three kinds: being ſuch as regard, firſt, the king's royal *character* or *dignity*; ſecondly, his royal *authority* or *power*; and, laſtly, his royal *income*. Theſe are neceſſary, to ſecure reverence to his perſon, obedience to his commands, and an affluent ſupply for the ordinary expences of government; without all of which it is impoſſible to maintain the exective power in due independence and vigour. Yet, in every branch of this large and extenſive dominion, our free conſtitution has interpoſed ſuch ſeaſonable checks and reſtrictions, as may curb it from trampling on thoſe liberties which it was meant to ſecure and eſtabliſh. The enormous weight of prerogative, if left to itſelf, (as in arbitrary governments it is), ſpreads havock and deſtruction among all the inferior movements: but, when balanced and bridled (as with us) by its proper counterpoiſe, timely and judiciouſly applied, its operations are then equable and regular; it invigorates the whole machine, and enables every part to anſwer the end of its conſtruction.

I. Of the royal *dignity*. Under every monarchical eſtabliſhment, it is neceſſary to diſtinguiſh the prince from his ſubjects, not only by the outward pomp and decorations of majeſty, but alſo by aſcribing to him certain qualities as inherent in his royal capacity, diſtinct from, and ſuperior to, thoſe of any other individual in the nation. For though a philoſophical mind will (ſays Sir William Blackſtone) conſider the royal perſon merely as one man appointed by mutual conſent to preſide over many others, and will pay him that reverence and duty which the principles of ſociety demand; yet the maſs of mankind will be apt to grow inſolent and refractory, if taught to conſider their prince as a man of no greater perfection than themſelves.—The law therefore aſcribes to the king, in his high political character, not only large powers and emoluments, which form his prerogative and revenue, but likewiſe certain attributes of a great and tranſcendent nature; by which the people are led to conſider him in the light of a ſuperior being, and to pay him that awful reſpect which may enable him with greater eaſe to carry on the buſineſs of government. This is what we underſtand by the royal dignity; the ſeveral branches of which we ſhall now proceed to enumerate.

1. And, firſt, the law aſcribes to the king the attribute of *ſovereignty*, or pre-eminency. See SOVEREIGNTY.

2. "The law alſo (according to Sir William Blackſtone) aſcribes to the king, in his political capacity, abſolute *perfection*. 'The king can do no wrong.' Which ancient and fundamental maxim (ſays he) is not to be underſtood as if every thing tranſacted by the government was of courſe juſt and lawful; but means only two things. Firſt, that whatever

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is exceptionable in the conduct of public affairs, is not to be imputed to the king, nor is he anſwerable for it perſonally to his people: for this doctrine would totally deſtroy that conſtitutional independence of the crown, which is neceſſary for the balance of power, in our free and active, and therefore compounded, conſtitution. And, ſecondly, it means that the prerogative of the crown extends not to do any injury; it is created for the benefit of the people, and therefore cannot be exerted to their prejudice.—"The king, moreover, (he obſerves), is not only incapable of *doing* wrong, but even of *thinking* wrong: he can never mean to do an improper thing: in him is no folly or weakneſs. And, therefore, if the crown ſhould be induced to grant any franchiſe or privilege to a ſubject contrary to reaſon, or in anywiſe prejudicial to the commonwealth or a private perſon, the law will not ſuppoſe the king to have meant either an unwiſe or an injurious action, but declares that the king was deceived in his grant; and thereupon ſuch grant is rendered void, merely upon the foundation of fraud and deception, either by or upon thoſe agents whom the crown has thought proper to employ. For the law will not caſt an imputation on that magiſtrate whom it entruſts with the executive power, as if he was capable of intentionally diſregarding his truſt: but attributes to mere impoſition (to which the moſt perfect of ſublunary beings muſt ſtill continue liable) thoſe little inadvertencies, which, if charged on the will of the prince, might leſſen him in the eyes of his ſubjects."

But this doctrine has been expoſed as ridiculous and abſurd, by Lord Abingdon, in his *Dedication to the collective Body of the People of England*. "Let us ſee (ſays he) how theſe maxims and their comments agree with the conſtitution, with nature, with reaſon, with common ſenſe, with experience, with fact, with precedent, and with Sir William Blackſtone himſelf; and whether, by the application of theſe rules of evidence thereto, it will not be found, that (from the want of attention to that important line of diſtinction which the conſtitution has drawn between the *king* of England and the *crown* of England) what was attributed to the *monarchy* has not been given to the *monarch*, what meant for the *kingſhip* conveyed to the *king*, what deſigned for the *thing* transferred to the *perſon*, what intended for *theory* applied to *practice*; and ſo in conſequence, that whilſt the premiſſes (of the perfection of the monarchy) be true, the concluſion (that the king can do no wrong) be not falſe.

"And, firſt, in reference to the conſtitution: to which if this matter be applied (meaning what it expreſſes, and if it do not it is unworthy of notice), it is ſubverſive of a principle in the conſtitution, upon which the preſervation of the conſtitution depends; I mean the principle of *reſiſtance*; a principle which, whilſt no man will now venture to gainſay, Sir William Blackſtone himſelf admits, '*is juſtifiable to the perſon of the prince*, when the being of the ſtate is endangered, and the public voice proclaims ſuch reſiſtance neceſſary;' and thus, by ſuch admiſſion, both diſproves the maxim, and overſets his own comment thereupon: for to ſay that 'the king can do no wrong,' and that 'he is incapable even of thinking wrong,' and then to admit that 'reſiſtance to his perſon is juſtifiable,' are ſuch jarring contradictions in themſelves, that, until reconciled, the neceſſity of argument is ſuſpended.

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"With reſpect then, in the next place, to the agreement of this maxim, and its comment, with nature, with reaſon, and with common ſenſe, I ſhould have thought myſelf ſufficiently juſtified in appealing to every man's own reflection for deciſion, if I had not been made to underſtand that nature, reaſon, and common ſenſe, had had nothing to do with either. Sir William Blackſtone ſays, 'That though a philoſophical mind will conſider the royal perſon merely as one man appointed by mutual conſent to preſide over others, and will pay him that reverence and duty which the principles of ſociety demand, yet the maſs of mankind will be apt to grow inſolent and refractory if taught to conſider their prince as a man of no greater perfection than themſelves; and therefore the law aſcribes to the king, in his high political character, certain attributes of a great and tranſcendent nature, by which the people are led to conſider him in the light of a ſuperior being, and to pay him that awful reſpect which may enable him with greater eaſe to carry on the buſineſs of government.' So that, in order to govern with greater eaſe (which by the bye is mere aſſertion without any proof), it is neceſſary to deceive the maſs of mankind, by making them believe, not only what a philoſophical mind cannot believe, but what it is impoſſible for any mind to believe; and therefore, in the inveſtigation of this ſubject, according to Sir William, neither nature, reaſon, nor common ſenſe, can have any concern.——

"It remains to examine in how much this maxim and its comment agree with experience, with fact, with precedent, and with Sir William Blackſtone himſelf. And here it is matter of moſt curious ſpeculation, to obſerve a maxim laid down, and which is intended for a rule of government, not only without a ſingle caſe in ſupport of it, but with a ſtring of caſes, that may be carried back to Egbert the firſt monarch of England, in direct oppoſition to the doctrine. Who is the man, that, reading the paſt hiſtory of this country, will ſhow us any king that has done no wrong? Who is the reader that will not find, that all the wrongs and injuries which the free conſtitution of this country has hitherto ſuffered, have been ſolely derived from the arbitrary meaſures of our kings? And yet the maſs of mankind are to look upon the king as a ſuperior being; and the maxim, that 'the king can do no wrong,' is to remain as an article of belief. But, without puſhing this inquiry any farther, let us ſee what encouragement Sir William Blackſtone himſelf has given us for our credulity. After ſtating the maxim, and preſenting us with a moſt lively picture, 'of our ſovereign lord thus *all perfect* and *immortal*,' what does he make this all-perfection and immortality in the end to come to? His words are theſe: 'For when king Charles's deluded brother attempted to *enſlave* the nation,' (*no wrong this, to be ſure*), 'he found it was beyond his power: the people both *could*, and *did*, reſiſt him; and in conſequence of ſuch reſiſtance, obliged him to quit his enterpriſe and his throne together *."

The ſum of all is this: That the crown of England and the king of England are diſtinguiſhable, and not ſynonymous terms: that allegiance is due *to the crown*, and through the crown *to the king*: that the attributes

* *Comment.* vol. iv p. 433.

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of the crown are ſovereignty, perfection, and perpetuity; but that it does not therefore follow that the king can do no wrong. It is indeed to be admitted, that in high reſpect for the crown, high reſpect is alſo due to the wearer of that crown; that is, to the king: but the crown is to be preferred to the king, for the firſt veneration is due to the conſtitution. It is likewiſe *to be ſuppoſed* that the king *will* do no wrong: and as, to prevent this, a privy council is appointed by the conſtitution to aſſiſt the king in the execution of the government; ſo if any wrong be done, 'theſe men,' as Monteſquieu expreſſes it, 'may be examined and puniſhed (A).'

"But if any future king ſhall think to ſcreen theſe evil counſellors from the juſt vengeance of the people, by becoming *his own miniſter*; and, in ſo doing, ſhall take for his ſanction *the attribute of perfection*, ſhall truſt to the deception of his being *a ſuperior being*, and cloak himſelf under the maxim that *the king can do no wrong*; I ſay, in ſuch a caſe, let the appeal already made to the conſtitution, to nature, to reaſon, to common ſenſe, to experience, to fact, to precedent, and to Sir William Blackſtone himſelf, ſuffice; and preclude the neceſſity of any further remarks from me (B)."

To proceed now to other particulars: The law determines, that in the king can be no negligence, or LACHES; and therefore no delay will bar his right. *Nullum tempus occurrit regi*, is the ſtanding maxim upon all occaſions: for the law intends that the king is always buſied for the public good, and therefore has not leiſure to aſſert his right within the times limited to ſubjects. In the king alſo can be no ſtain or corruption of blood: for if the heir to the crown were attainted of treaſon or felony, and afterwards the crown ſhould deſcend to him, this would purge the attainder *ipſo facto*. And therefore, when Henry VII. who as earl of Richmond ſtood attainted, came to the crown, it was not thought neceſſary to paſs an act of parliament to reverſe this attainder; becauſe, as Lord Bacon in his hiſtory of that prince informs us, it was agreed that the aſſumption of the crown had at once purged all attainders. Neither can the king, in judgment of law, as king, ever be a minor or under age; and therefore his royal grants and aſſents to acts of parliament are good, though he has not in his natural capacity attained the legal age of 21. By a ſtatute, indeed, 28 Hen. VIII. c. 17. power was given to future kings to reſcind and revoke all acts of parliament that ſhould be made while they were under the age of 24: but this was repealed by the ſtatute 1 Edward VI. c. 11. ſo far as related to that prince, and both ſtatutes are declared to be determined by 24 Geo. II. c. 24. It hath alſo been uſually thought prudent, when the heir-apparent has been very young, to appoint a protector, guardian, or regent, for a limited time: but the very neceſſity of ſuch extraordinary proviſion is ſufficient to demonſtrate the truth of that maxim of common law, that in the king is no minority; and therefore he hath no legal guardian. See REGENT.

Blackſt. Comment.

3. A third attribute of the king's majeſty is his *perpetuity*. The law aſcribes to him, in his political capacity, an abſolute immortality. The king never dies. Henry, Edward, or George, may die; but the king ſurvives them all. For, immediately upon the deceaſe of the reigning prince in his natural capacity, his kingſhip or imperial dignity, by act of law, without any *interregnum* or interval, is veſted at once in his heir; who is, *eo inſtanti*, king to all intents and purpoſes. And ſo tender is the law of ſuppoſing even a poſſibility of his death, that his natural diſſolution is generally called his *demiſe; dimiſſio regis vel coronæ:* an expreſſion which ſignifies merely a transfer of property; for, as is obſerved in Plowden, when we ſay the demiſe of the crown, we mean only, that, in conſequence of the diſunion of the king's body-natural from his body-politic, the kingdom is transferred or demiſed to his ſucceſſor, and ſo the royal dignity remains perpetual. Thus, too, when Edward the fourth, in the tenth year of his reign, was driven from his throne for a few months by the houſe of Lancaſter, this temporary transfer of his dignity was denominated his *demiſe;* and all proceſs was held to be diſcontinued, as upon a natural death of the king.

II. We are next to conſider thoſe branches of the royal prerogative which inveſt this our ſovereign lord with a number of *authorities* and *powers;* in the exertion whereof conſiſts the executive part of government. This is wiſely placed in a ſingle hand by the Britiſh conſtitution, for the ſake of unanimity, ſtrength, and diſpatch. Were it placed in many hands, it would be ſubject to many wills: many wills, if diſunited and drawing different ways, create weakneſs in a government; and to unite thoſe ſeveral wills, and reduce them to one, is a work of more

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(A) Except the parliament, which is the great council of the nation, the judges, and the peers, who, being the hereditary counſellors of the crown, have not only a right, but are bound *in foro conſcientiæ* to adviſe the king for the public good, the conſtitution knows of no other counſel than the privy council. Any other counſel, like Clifford, Arlington, Buckingham, Aſhley, Lauderdale, and, as the initial letters of theſe names expreſs, is a CABAL, and as ſuch ſhould be ſuppreſſed. Nat. Bacon, ſpeaking of the loſs of power in the grand council of lords, ſays, "The ſenſe of ſtate once contracted into a privy-council, is ſoon recontracted into a cabinet-council, and laſt of all into a *favourite* or two; which many times brings damage to the public, and both *themſelves* and *kings* into extreme *precipices;* partly for want of maturity, but principally through the providence of God over-ruling irregular courſes to the hurt of ſuch as walk in them." *Pol. Diſc.* part 2. p. 201.

(B) For experience, fact, and precedent, ſee the reigns of king John, Henry III. Edward. II. Richard II. Charles I. and James II. See alſo *Mirror of Juſtices;* where it is ſaid, "that this grand aſſembly (meaning the now parliament, or then Wittena-gemotte) is to confer the government of God's people, how they may be kept from ſin, live in quiet, and have right done them, according to the cuſtoms and laws; and more eſpecially *of wrong done by the king*, queen, or their children:" to which Nat. Bacon adds this note: "At this time *the king might do wrong*, &c. and ſo ſay Bracton and Fleta of the *kings* in their time." *Diſc.* part 1. p. 37. Lond. 1739.

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more time and delay than the exigencies of ſtate will afford. The king of England is therefore not only the chief, but properly the ſole, magiſtrate of the nation; all others acting by commiſſion from, and in due ſubordination to, him: in like manner as, upon the great revolution in the Roman ſtate, all the powers of the ancient magiſtracy of the commonwealth were concentered in the new emperor; ſo that, as Gravina expreſſes it, *in ejus unius perſona veteris rei publicæ vis atque majeſtas per cumulatas magiſtratuum poteſtates exprimebatur.*

In the exertion of lawful prerogative the king is held to be abſolute; that is, ſo far abſolute, that there is no legal authority that can either delay or reſiſt him. He may reject what bills, may make what treaties, may coin what money, may create what peers, may pardon what offences, he pleaſes: unleſs where the conſtitution hath expreſsly, or by evident conſequence, laid down ſome exception or boundary; declaring, that thus far the prerogative ſhall go and no farther. For otherwiſe the power of the crown would indeed be but a name and a ſhadow, inſufficient for the ends of government, if, where its juriſdiction is clearly eſtabliſhed and allowed, any man or body of men were permitted to diſobey it, in the ordinary courſe of law: we do not now ſpeak of thoſe *extraordinary* recourſes to the firſt principles, which are neceſſary when the contracts of ſociety are in danger of diſſolution, and the law proves too weak a defence againſt the violence of fraud or oppreſſion. And yet the want of attending to this obvious diſtinction has occaſioned theſe doctrines, of abſolute power in the prince and of national reſiſtance by the people, to be much miſunderſtood and perverted, by the advocates for ſlavery on the one hand, and the demagogues of faction on the other. The former, obſerving the abſolute ſovereignty and tranſcendent dominion of the crown laid down (as it certainly is) moſt ſtrongly and emphatically in our law-books as well as our homilies, have denied that any caſe can be excepted from ſo general and poſitive a rule; forgetting how impoſſible it is, in any practical ſyſtem of laws, to point out beforehand thoſe eccentrical remedies, which the ſudden emergence of national diſtreſs may dictate, and which that alone can juſtify. On the other hand, over-zealous republicans, feeling the abſurdity of unlimited paſſive obedience, have fancifully (or ſometimes factiouſly) gone over to the other extreme: and, becauſe reſiſtance is juſtifiable to the perſon of the prince when the being of the ſtate is endangered, and the public voice proclaims ſuch reſiſtance neceſſary, they have therefore allowed to every individual the right of determining this expedience, and of employing private force to reſiſt even private oppreſſion. A doctrine productive of anarchy, and (in conſequence) equally fatal to civil liberty as tyranny itſelf. For civil liberty, rightly underſtood, conſiſts in protecting the rights of individuals by the united force of ſociety: ſociety cannot be maintained, and of courſe can exert no protection, without obedience to ſome ſovereign power; and obedience is an empty name, if every individual has a right to decide how far he himſelf ſhall obey.

Blackſt. Comment.

In the exertion, therefore, of thoſe prerogatives which the law has given him, the king is irreſiſtible and abſolute, according to the forms of the conſtitution. And yet, if the conſequence of that exertion be manifeſtly to the grievance or diſhonour of the kingdom, the parliament will call his adviſers to a juſt and ſevere account. For prerogative conſiſting (as Mr Locke has well defined it) in the diſcretionary power of acting for the public good where the poſitive laws are ſilent, if that diſcretionary power be abuſed to the public detriment, ſuch prerogative is exerted in an unconſtitutional manner. Thus the king may make a treaty with a foreign ſtate, which ſhall irrevocably bind the nation; and yet, when ſuch treaties have been judged pernicious, impeachments have purſued thoſe miniſters by whoſe agency or advice they were concluded.

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The prerogatives of the crown (in the ſenſe under which we are now conſidering them) reſpect either this nation's intercourſe with foreign nations, or its own domeſtic government and civil polity.

With regard to *foreign concerns*, the king is the delegate or repreſentative of his people. It is impoſſible that the individuals of a ſtate, in their collective capacity, can tranſact the affairs of that ſtate with another community equally numerous as themſelves. Unanimity muſt be wanting to their meaſures, and ſtrength to the execution of their counſels. In the king therefore, as in a centre, all the rays of his people are united, and form by that union a conſiſtency, ſplendor, and power, that make him feared and reſpected by foreign potentates; who would ſcruple to enter into any engagement, that muſt afterwards be reviſed and ratified by a popular aſſembly. What is done by the royal authority, with regard to foreign powers, is the act of the whole nation: what is done without the king's concurrence, is the act only of private men. And ſo far is this point carried by our law, that it hath been held, that ſhould all the ſubjects of England make war with a king in league with the king of England, without the royal aſſent, ſuch war is no breach of the league. And, by the ſtatute 2 Hen. V. c. 6. any ſubject committing acts of hoſtility upon any nation in league with the king, was declared to be guilty of high treaſon: and, though that act was repealed by the ſtatute 20 Hen. VI. c. 11. ſo far as relates to the making this offence high treaſon, yet ſtill it remains a very great offence againſt the law of nations, and puniſhable by our laws, either capitally or otherwiſe, according to the circumſtances of the caſe.

1. The king therefore, conſidered as the repreſentative of his people, has the ſole power of ſending ambaſſadors to foreign ſtates, and receiving ambaſſadors at home.

2. It is alſo the king's prerogative to make treaties, leagues, and alliances, with foreign ſtates and princes. For it is, by the law of nations, eſſential to the goodneſs of a league, that it be made by the ſovereign power; and then it is binding upon the whole community: and in Britain the ſovereign power, *quoad hoc*, is veſted in the perſon of the king. Whatever contracts therefore he engages in, no other power in the kingdom can legally delay, reſiſt, or annul. And yet, leſt this plenitude of authority ſhould be abuſed to the detriment of the public, the conſtitution (as was hinted before) hath here interpoſed a check, by the means of parliamentary impeachment, for the puniſhment of ſuch miniſters as from criminal motives adviſe or conclude any treaty, which ſhall afterwards be judged to derogate from the honour and intereſt of the nation.

3. Upon the ſame principle the king has alſo the ſole prerogative of making war and peace. For it is

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held by all the writers on the law of nature and nations, that the right of making war, which by nature ſubſiſted in every individual, is given up by all private perſons that enter into ſociety, and is veſted in the ſovereign power: and this right is given up, not only by individuals, but even by the entire body of people that are under the dominion of a ſovereign. It would indeed be extremely improper, that any number of ſubjects ſhould have the power of binding the ſupreme magiſtrate, and putting him againſt his will in a ſtate of war. Whatever hoſtilities, therefore, may be committed by private citizens, the ſtate ought not to be affected thereby; unleſs that ſhould juſtify their proceedings, and thereby become partner in the guilt. And the reaſon which is given by Grotius, why, according to the law of nations, a denunciation of war ought always to precede the actual commencement of hoſtilities, is not ſo much that the enemy may be put upon his guard (which is matter rather of magnanimity than right), but that it may be certainly clear that the war is not undertaken by private perſons, but by the will of the whole community; whoſe right of willing is in this caſe transferred to the ſupreme magiſtrate by the fundamental laws of ſociety. So that, in order to make a war completely effectual, it is neceſſary with us in Britain that it be publicly declared and duly proclaimed by the king's authority; and then, all parts of both the contending nations, from the higheſt to the loweſt, are bound by it. And wherever the right reſides of beginning a national war, there alſo muſt reſide the right of ending it, or the power of making peace. And the ſame check of parliamentary impeachment, for improper or inglorious conduct, in beginning, conducting, or concluding a national war, is in general ſufficient to reſtrain the miniſters of the crown from a wanton or injurious exertion of this great prerogative.

4. But, as the delay of making war may ſometimes be detrimental to individuals who have ſuffered by depredations from foreign potentates, our laws have in ſome reſpects armed the ſubject with powers to impel the prerogative; by directing the miniſters of the crown to iſſue letters of marque and repriſal upon due demand: the prerogative of granting which is nearly related to, and plainly derived from, that other of making war; this being indeed only an incomplete ſtate of hoſtilities, and generally ending in a formal denunciation of war. Theſe letters are grantable, by the law of nations, whenever the ſubjects of one ſtate are oppreſſed and injured by thoſe of another, and juſtice is denied by that ſtate to which the oppreſſor belongs. In this caſe, letters of marque and repriſal (words in themſelves ſynonymous, and ſignifying a taking in return) may be obtained, in order to ſeize the bodies or goods of the ſubjects of the offending ſtate, until ſatisfaction be made, wherever they happen to be found. And indeed this cuſtom of repriſals ſeems dictated by nature herſelf; for which reaſon we find in the moſt ancient times very notable inſtances of it. But here the neceſſity is obvious of calling in the ſovereign power, to determine when repriſals may be made; elſe every private ſufferer would be a judge in his own cauſe. In purſuance of which principle, it is with us declared by the ſtatute 4 Hen. V. c. 7. that if any ſubjects of the realm are oppreſſed in time of truce by any foreigners, the king will grant marque in due form to all that feel themſelves grieved. See Marque. Prerogative.

5. Upon exactly the ſame reaſon ſtands the prerogative of granting ſafe-conducts; without which, by the law of nations, no member of one ſociety has a right to intrude into another. And therefore Puffendorf very juſtly reſolves, that it is left in the power of all ſtates to take ſuch meaſures about the admiſſion of ſtrangers as they think convenient; thoſe being ever excepted who are driven on the coaſts by neceſſity, or by any cauſe that deſerves pity or compaſſion. Great tenderneſs is ſhown by our laws, not only to foreigners in diſtreſs (ſee Wreck), but with regard alſo to the admiſſion of ſtrangers who come ſpontaneouſly: for ſo long as their nation continues at peace with ours, and they themſelves behave peaceably, they are under the king's protection; though liable to be ſent home whenever the king ſees occaſion. But no ſubject of a nation at war with us can, by the law of nations, come into the realm, nor can travel himſelf upon the high ſeas, or ſend his goods and merchandize from one place to another, without danger of being ſeized by our ſubjects, unleſs he has letters of ſafe-conduct; which, by divers ancient ſtatutes, muſt be granted under the king's great ſeal and inrolled in chancery, or elſe they are of no effect; the king being ſuppoſed the beſt judge of ſuch emergencies, as may deſerve exception from the general law of arms. But paſſports under the king's ſign-manual, or licences from his ambaſſadors abroad, are now more uſually obtained, and are allowed to be of equal validity.

Theſe are the principal prerogatives of the king reſpecting this nation's intercourſe with foreign nations; in all of which he is conſidered as the delegate or repreſentative of his people. But in domeſtic affairs, he is conſidered in a great variety of characters, and from thence there ariſes an abundant number of other prerogatives.

1. He is a conſtituent part of the ſupreme legiſlative power; and, as ſuch, has the prerogative of rejecting ſuch proviſions in parliament as he judges improper to be paſſed. The expediency of which conſtitution has before been evinced at large under the article Parliament. We ſhall only farther remark, that the king is not bound by any act of parliament, unleſs he be named therein by ſpecial and particular words. The moſt general words that can be deviſed (any perſon or perſons, bodies politic, or corporate, &c.) affect not him in the leaſt, if they may tend to reſtrain or diminiſh any of his rights or intereſts. For it would be of moſt miſchievous conſequence to the public, if the ſtrength of the executive power were liable to be curtailed, without its own expreſs conſent, by conſtructions and implications of the ſubject. Yet, where an act of parliament is expreſsly made for the preſervation of public rights and the ſuppreſſion of public wrongs, and does not interfere with the eſtabliſhed rights of the crown, it is ſaid to be binding as well upon the king as upon the ſubject: and, likewiſe, the king may take the benefit of any particular act, though he be not eſpecially named.

2. The king is conſidered, in the next place, as the generaliſſimo, or the firſt in military command, within the kingdom. The great end of ſociety is to protect the weakneſs of individuals by the united ſtrength of the

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the community; and the principal uſe of government is to direct that united ſtrength in the beſt and moſt effectual manner, to anſwer the end propoſed. Monarchical government is allowed to be the fitteſt of any for this purpoſe: it follows therefore, from the very end of its inſtitution, that in a monarchy the military power muſt be truſted in the hands of the prince.

In this capacity, therefore, of general of the kingdom, the king has the ſole power of raiſing and regulating fleets and armies. The manner in which they are raiſed and regulated is explained under the article *Military State*. We are now only to conſider the prerogative of enliſting and of governing them: which indeed was diſputed and claimed, contrary to all reaſon and precedent, by the long parliament of king Cha. I.; but, upon the reſtoration of his ſon, was ſolemnly declared by the ſtatute 13 Charles II. c. 6. to be in the king alone: for that the ſole ſupreme government and command of the militia within all his majeſty's realms and dominions, and of all forces by ſea and land, and of all forts and places of ſtrength, ever was and is the undoubted right of his majeſty, and his royal predeceſſors, kings and queens of England; and that both or either houſe of parliament cannot, nor ought to, pretend to the ſame.

This ſtatute, it is obvious to obſerve, extends not only to fleets and armies, but alſo to forts and other places of ſtrength within the realm; the ſole prerogative, as well of erecting, as manning and governing of which, belongs to the king in his capacity of general of the kingdom: and all lands were formerly ſubject to a tax, for building of caſtles wherever the king thought proper. This was one of the three things, from contributing to the performance of which no lands were exempted, and therefore called by the Anglo-Saxons the *trinoda neceſſitas; ſc. pontis reparatio, arcis conſtructio, et expeditio contra hoſtem.* And this they were called upon to do ſo often, that, as Sir Edward Coke from M. Paris aſſures us, there were in the time of Henry II. 1115 caſtles ſubſiſting in England. The inconveniencies of which, when granted out to private ſubjects, the lordly barons of thoſe times, were ſeverely felt by the whole kingdom; for, as William of Newburgh remarks in the reign of king Stephen, *erant in Anglia quodammodo tot reges, vel potius tyranni, quot domini caſtellorum;* but it was felt by none more ſenſibly than by two ſucceeding princes, king John and king Henry III. And therefore, the greateſt part of them being demoliſhed in the baron's wars, the kings of after times have been very cautious of ſuffering them to be rebuilt in a fortified manner: and Sir Edward Coke lays it down, that no ſubject can build a caſtle, or houſe of ſtrength imbattled, or other fortreſs defenſible, without the licence of the king; for the danger which might enſue, if every man at his pleaſure might do it.

It is partly upon the ſame, and partly upon a fiſcal foundation, to ſecure his marine revenue, that the king has the prerogative of appointing *ports* and *havens*, or ſuch places only, for perſons and merchandize to paſs into and out of the realm, as he in his wiſdom ſees proper. By the feodal law, all navigable rivers and havens were computed among the regalia, and were ſubject to the ſovereign of the ſtate. And in England it hath always been held, that the king is lord of the whole ſhore, and particularly is the guardian of the ports and havens, which are the inlets and gates of the realm: and therefore, ſo early as the reign of king John, we find ſhips ſeized by the king's officers for putting in at a place that was not a legal port. Theſe legal ports were undoubtedly at firſt aſſigned by the crown; ſince to each of them a court of portmote is incident, the juriſdiction of which muſt flow from the royal authority: the *great ports* of the ſea are alſo referred to, as well known and eſtabliſhed, by ſtatute 4 Hen. IV. c. 20. which prohibits the landing elſewhere under pain of confiſcation: and the ſtatute 1 Eliz. c. 11. recites, that the franchiſe of lading and diſcharging had been frequently granted by the crown.

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But though the king had a power of granting the franchiſe of havens and ports, yet he had not the power of reſumption, or of narrowing and confining their limits when once eſtabliſhed; but any perſon had a right to load or diſcharge his merchandiſe in any part of the haven: whereby the revenue of the cuſtom was much impaired and diminiſhed, by fraudulent landings in obſcure and private corners. This occaſioned the ſtatutes of 1 Eliz. c. 11. and 13 and 14 Car. II. c. 11. § 14. which enable the crown by commiſſion, to aſcertain the limits of all ports, and to aſſign proper wharfs and quays in each port, for the excluſive landing and loading of merchandiſe.

The erection of beacons, light-houſes, and ſea-marks, is alſo a branch of the royal prerogative: whereof the firſt was anciently uſed in order to alarm the country, in caſe of the approach of an enemy; and all of them are ſignally uſeful in guiding and preſerving veſſels at ſea by night as well as by day. See Beacon.

3. Another capacity in which the king is conſidered in domeſtic affairs, is as the fountain of juſtice and general conſervator of the peace of the kingdom. See the article *Fountain of Justice*.

4. The king is likewiſe the fountain of honour, of office, and of privilege: and this in a different ſenſe from that wherein he is ſtyled the *fountain of juſtice*; for here he is really the parent of them. See the articles *Fountain of Justice* and *Fountain of Honour*.

5. Another light, in which the laws of England conſider the king with regard to domeſtic concerns, is as the arbiter of commerce. By commerce, we at preſent mean domeſtic commerce only; for the king's prerogative with regard to which, ſee *Regulation of Weights and Meaſures*, Money, &c.

6. The king is, laſtly, conſidered by the laws of England as the head and ſupreme governor of the national church.

To enter into the reaſons upon which this prerogative is founded is matter rather of divinity than of law. We ſhall therefore only obſerve, that by ſtatute 26 Hen. VIII. c. 1. (reciting that the king's majeſty juſtly and rightfully is and ought to be the ſupreme head of the church of England; and ſo had been recogniſed by the clergy of that kingdom in their convocation) it is enacted, that the king ſhall be reputed the only ſupreme head in earth of the church of England; and ſhall have, annexed to the imperial crown of this realm, as well the title and ſtyle thereof, as all juriſdictions, authorities, and commodities, to the ſaid dignity of ſupreme head of the church appertaining. And another ſtatute to the ſame purport was made, 1 Eliz. c. 1.

In virtue of this authority the king convenes, prorogues,

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rogues, reſtrains, regulates, and diſſolves, all eccleſiaſtical ſynods or convocations. This was an inherent prerogative of the crown long before the time of Henry VIII. as appears by the ſtatute 8 Hen. VI. c. 1. and the many authors, both lawyers and hiſtorians, vouched by Sir Edward Coke. So that the ſtatute 25 Hen. VIII. c. 19. which reſtrains the convocation from making or putting in execution any canons repugnant to the king's prerogative, or the laws, cuſtoms, and ſtatutes of the realm, was merely declaratory of the old common law: that part of it only being new, which makes the king's royal aſſent actually neceſſary to the validity of every canon. The convocation or eccleſiaſtical ſynod, in England, differs conſiderably in its conſtitution from the ſynods of other Chriſtian kingdoms: thoſe conſiſting wholly of biſhops; whereas in England the convocation is the miniature of a parliament, wherein the archbiſhop preſides with regal ſtate; the upper houſe of biſhops repreſents the houſe of lords; and the lower houſe, compoſed of repreſentatives of the ſeveral dioceſes at large, and of each particular chapter therein, reſembles the houſe of commons with its knights of the ſhire and burgeſſes. This conſtitution is ſaid to be owing to the policy of Edward I. who thereby at one and the ſame time let in the inferior clergy to the privileges of forming eccleſiaſtical canons (which before they had not), and alſo introduced a method of taxing eccleſiaſtical benefices, by conſent of convocation.

From this prerogative alſo, of being the head of the church, ariſes the king's right of nomination to vacant biſhoprics, and certain other eccleſiaſtical preferments.

As head of the church, the king is likewiſe the *dernier reſort* in all eccleſiaſtical cauſes; an appeal lying ultimately to him in chancery from the ſentence of every eccleſiaſtical judge: which right was reſtored to the crown by ſtatute 25 Hen. VIII. c. 9.

III. The king's fiſcal prerogatives, or ſuch as regard his revenue. See the article REVENUE.

PREROGATIVE-Court, an Engliſh court eſtabliſhed for the trial of all teſtamentary cauſes, where the deceaſed hath left *bona notabilia* within two different dioceſes. In which caſe the probate of wills belongs to the archbiſhop of the province, by way of ſpecial prerogative. And all cauſes relating to the wills, adminiſtrations, or legacies of ſuch perſons, are originally cognizable herein, before a judge appointed by the archbiſhop, called the *judge of the prerogative-court*; from whom an appeal lies by ſtatute 25 Hen. VIII. c. 19. to the king in chancery, inſtead of the pope as formerly.

PRESAGE, in antiquity, denotes an augury, or ſign of ſome future event; which was chiefly taken from the flight of birds, the entrails of victims, &c. See AUGURY and ARUSPICES.

PRESBURG, the capital of the kingdom of Lower Hungary, called by the inhabitants *Poſony* and *Preſporen*, ſituated on the Danube, about 46 miles eaſt from Vienna, and 75 from Buda. The caſtle, in which the regalia are kept, ſtands on a hill above the town. Here the ſtates aſſemble; and in the cathedral, dedicated to St Martin, the king is crowned. The town is not very large, nor well built; but is very ancient, pleaſantly ſituated, and enjoys a good air. Its fortifications are only a double wall and ditch. In the lower ſuburbs is a hill, where the king, after his coronation, goes on horſeback, and brandiſhes St Stephen's ſword towards the four cardinal points, intimating, that he will defend his country againſt all its enemies. Beſides the cathedral, there are ſeveral other Popiſh and one Lutheran church, with a Jeſuits college, three convents, and two hoſpitals. It gives name to a county; and is the reſidence of the archbiſhop of Gran, who is primate, chief ſecretary, and chancellor of the kingdom, *legatus natus* of the Papal ſee, and prince of the holy Roman empire. E. Long. 17. 30. N. Lat. 48. 20.

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PRESBYTÆ, perſons whoſe eyes are too flat to refract the rays ſufficiently, ſo that unleſs the object is at ſome diſtance, the rays coming from it will paſs through the retina before their union, conſequently viſion is confuſed; old people are uſually the ſubjects of this diſeaſe. In order to remedy, or at leaſt to palliate, this defect, the perſon ſhould firſt uſe glaſſes which do not magnify, and from them paſs gradually to more convex ſpectacles, which ſhorten the focus.

PRESBYTER, in the primitive Chriſtian church, an elder, one of the ſecond order of eccleſiaſtics; the other two being biſhops and deacons. See the articles BISHOP and DEACON.

Preſbyter or elder is a word borrowed from the Greek tranſlation of the Old Teſtament, where it commonly ſignifies ruler or governor; it being a note of office and dignity, not of age; and in this ſenſe biſhops are ſometimes called *preſbyters* in the New Teſtament. The preſbyters might baptize, preach, conſecrate, and adminiſter the euchariſt in the biſhop's abſence, or in his preſence if he authoriſed and deputed them; and the biſhops did ſcarce any thing in the government of the church without their advice, conſent, and amicable concurrence.

The grand diſpute between the followers of the Geneva and Roman diſcipline, is about the fameneſs and difference of preſbyters and biſhops at the time of the apoſtles. See EPISCOPACY, INDEPENDENTS, and the following article.

1 Diſcriminating principle of the Preſbyterians.

PRESBYTERIANS, Proteſtants, ſo called from their maintaining that the government of the church appointed in the New Teſtament was by preſbyteries, that is, by aſſociations of miniſters and ruling elders, poſſeſſed all of equal powers, without any ſuperiority among them either in office or in order.

The Preſbyterians believe, thatthe authority of their miniſters to preach the goſpel, to adminiſter the ſacraments of baptiſm and the Lord's ſupper, and to feed the flock of Chriſt, is derived from the Holy Ghoſt by the impoſition of the hands of the preſbytery; and they oppoſe the independent ſcheme of the common rights of Chriſtians by the ſame arguments which are uſed for that purpoſe by the Epiſcopalians (ſee EPISCOPACY). They affirm, however, that there is no order in the church as eſtabliſhed by Chriſt and his apoſtles ſuperior to that of preſbyters; that all miniſters being ambaſſadors of Chriſt, are equal by their commiſſion; that *preſbyter* and *biſhop*, though different words, are of the ſame import; and that prelacy was gradually eſtabliſhed upon the primitive practice of making the *moderator* or ſpeaker of the preſbytery a permanent officer.

2 Scriptural arguments againſt epiſcopacy.

Theſe poſitions they maintain againſt the Epiſcopalians by the following ſcriptural arguments. They obſerve, that the apoſtles planted churches by ordaining biſhops and deacons in every city; that the miniſters which in one verſe are called biſhops are in the next

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perhaps denominated presbyters; that we nowhere read in the New Testament of bishops, presbyters, and deacons, in any one church; and that therefore we are under the necessity of concluding *bishop* and *presbyter* to be two names for the same church officer. This is apparent from Peter's exhortation to the *elders* or *presbyters* who were among the Jewish Christians. "The *elders* (presbyters) which are among you I exhort, who am also an *elder*, and a witness of the sufferings of Christ, and also a partaker of the glory that shall be revealed: Feed the flock of God which is among you, taking the *oversight* thereof (επισκοπουντες acting as *bishops* thereof), not by constraint, but willingly; not for filthy lucre, but of a ready mind; neither as being LORDS over God's heritage, but being ensamples to the flock*." From this passage it is evident, that the presbyters not only fed the flock of God, but also governed that flock with episcopal powers; and that the apostle himself, as a church officer, was nothing more than a presbyter or elder. The identity of the office of bishop and presbyter is still more apparent from Heb. xiii. 7. 17. and 1 Thess. v. 12.; for the bishops are there represented as governing the flock, speaking to them the word of God, watching for their souls, and discharging various offices, which it is impossible for any man to perform to more than one congregation.

* 1. Peter v. 1, 2, 3.

3 Reasons for supposing bishops and presbyters of the same order.

From the last cited text it is evident, that the bishops (πρεσβυτερους) of the Thessalonian churches had the pastoral care of no more souls than they could hold personal communion with in God's worship; for they were such as all the people were to *know*, *esteem*, and *love*, as those that not only were *over them*, but also "closely laboured among them and admonished them." But diocesan bishops, whom ordinarily the hundredth part of their flock never hear nor see, cannot be those bishops by whom that flock is admonished, nor can they be what Peter requires the bishops of the Jewish converts to be *ensamples to the flock*. It is the opinion of Dr Hammond, who was a very learned divine, and a zealot for episcopacy, that the *elders* whom the apostle James desires† the sick to call for, were of the highest permanent order of ecclesiastical officers; but it is self-evident that those elders cannot have been diocesan bishops, otherwise the sick must have been often without the reach of the remedy proposed to them.

† Chap. v. 14.

There is nothing in Scripture upon which the Episcopalian is more ready to rest his cause than the alleged episcopacy of Timothy and Titus; of whom the former is said to have been bishop of Ephesus, and the latter bishop of Crete; yet the Presbyterian thinks it as clear as the noon-day sun, that the presbyters of Ephesus were supreme governors under Christ of the Ephesian churches, at the very time that Timothy is pretended to have been their proper diocesan.

In Acts xx. 17, &c. we read, that "from Miletus Paul sent to Ephesus, and called the elders (presbyters) of the church. And when they were come to him, he said unto them, Ye know, from the first day that I came into Asia, after what manner I have been with you, at all seasons. And now I know that ye all, among whom I have gone preaching the kingdom of God, shall see my face no more. Wherefore I take you to record this day, that I am pure from the blood of all men. For I have not shunned to declare unto you all the counsel of God. Take heed therefore unto yourselves, and to all the flock over which the Holy Ghost hath made you overseers (επισκοπους *bishops*), to feed the church of God, which he hath purchased with his own blood. For I know this, that after my departure shall grievous wolves enter in among you, not sparing the flock. Also of your ownselves shall men arise, speaking perverse things, to draw away disciples after them. Therefore watch, and remember, that by the space of three years, I ceased not to warn every one night and day with tears. And now, brethren, I recommend you to God, and to the word of his grace," &c.

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4 The pastors of Ephesus of equal authority.

From this passage, it is evident that there was in the city of Ephesus a plurality of pastors of equal authority without any superior pastor or bishop over them; for the apostle directs his discourse to them all in common, and gives them equal power over the whole flock. Dr Hammond indeed imagines, that the elders whom Paul called to Miletus were the *bishops* of *Asia*, and that he sent for them to Ephesus, because that city was the metropolis of the province. But were this opinion well-founded, it is not conceivable that the sacred writer would have called them the elders of the church of *Ephesus*, but the elders of the *church in general*, or the elders of the *churches in Asia*. Besides, it is to be remembered, that the apostle was in such haste to be at Jerusalem, that the sacred historian measures his time by *days*; whereas it must have required several months to call together the bishops or elders of all the cities of Asia; and he might certainly have gone to meet them at Ephesus in less time than would be requisite for their meeting in that city and proceeding thence to him at Miletus. They must therefore have been either the joint pastors of one congregation, or the pastors of different congregations in one city: and as it was thus in Ephesus, so was it in Philippi; for we find the apostle addressing his epistle "to all the saints in Christ Jesus which are at Philippi, with the bishops and deacons." From the passage before us it is likewise plain, that the presbyters of Ephesus had not only the *name* but the whole *power* of bishops given to them by the Holy Ghost; for they are enjoined to do the whole work of bishops—ποιμαινειν την εκκλησιαν του θεου—which signifies, to *rule* as well as *feed* the church of God. Whence we see, that the apostle makes the power of *governing* inseparable from that of *preaching* and *watching*; and that according to him, all who are preachers of God's word, and watchmen of souls, are necessarily rulers or governors of the church, without being accountable for their management to any prelate, but only to their Lord Christ from whom their power is derived.

5 Timothy no bishop.

It appears therefore, that the apostle Paul left in the church of Ephesus, which he had planted, no other successors to himself than *presbyter-bishops* or Presbyterian ministers, and that he did not devolve his power upon any prelate. Timothy, whom the Episcopalians allege to have been the first bishop of Ephesus, was present when this settlement was made*; and it is surely not to be supposed, that, had he been their bishop, the apostle would have devolved the whole episcopal power upon the presbyters before his face. If ever there was a season fitter than another for pointing out the duty of this supposed bishop to his diocese, and his presbyters duty to him, it was surely when Paul was taking his final leave of them, and discoursing so pathetically con-

* Acts xx. 5.

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cerning the duty of *overseers*, the coming of ravenous wolves, and the consequent hazard of the flock. In this farewel discourse, he tells them that "he had not shunned to declare unto them all the counsel of God." But with what truth could this have been said, if obedience to a diocesan bishop had been any part of their duty either at the time of the apostle's speaking or at any future period? He foresaw that ravenous wolves would enter in among them, and that even some of themselves should arise speaking perverse things; and if, as the Episcopalians allege, diocesan episcopacy was the remedy provided for those evils, is it not strange, passing strange, that the inspired preacher did not foresee that Timothy, who was standing beside him, was destined to fill that important office; or if he did foresee it, that he omitted to recommend him to his future charge, and to give him proper instructions for the discharge of his duty?

6 But an evangelist.

But if Timothy was not bishop of Ephesus, what, it may be asked, was his office in that city? for that he resided there for some time, and was by the apostle invested with authority to ordain and rebuke presbyters, are facts about which all parties are agreed, and which indeed cannot be controverted by any reader of Paul's epistles. To this the Presbyterian replies with confidence, that the power which Timothy exercised in the church of Ephesus was that of an evangelist †, and not a fixed prelate. But, according to Eusebius, the work of an evangelist was, "to lay the foundations of the faith in barbarous nations, and to constitute among them pastors; after which he passed on to other countries." Accordingly we find, that Timothy was resident for a time at Philippi and Corinth ‡ as well as at Ephesus, and that he had as much authority over those churches as over that of which he is said to have been the fixed bishop. "Now, if Timotheus come, see that he may be with you without fear, for he worketh the work of the Lord, as I also do. Let no man therefore despise him." This text might lead us to suppose, that Timothy was bishop of Corinth as well as of Ephesus; for it is stronger than that upon which his episcopacy of the latter church is chiefly built. The apostle says, "I besought thee* to abide still at Ephesus, when I went into Macedonia, that thou mightest charge some that they teach no other doctrine." But had Timothy been the fixed bishop of that city, there would surely have been no necessity for *beseeching* him to abide with his flock. It is to be observed, too, that the first epistle to Timothy, which alone was written to him during his residence at Ephesus, was of a date prior to Paul's meeting with the elders of that church at Miletus; for in the epistle he hopes to come to him shortly, whereas he tells the elders at Miletus that they should see his face no more. This being the case, it is evident that Timothy was left by the apostle at Ephesus only to supply his place during his temporary absence at Macedonia, and that he could not possibly have been constituted fixed bishop of that church, since the episcopal powers were afterwards committed to the presbyters by the Holy Ghost in his presence.

† 2 Tim. 4. 5.

‡ Phil. ii. 19. 1 Cor. iv. 17. xvi. 10, 11.

* 1 Tim. i. 3.

7 Presbyterate the highest permanent office in the church.

The identity of the office of bishop and presbyter being thus clearly established, it follows, that the presbyterate is the highest permanent office in the church, and that every faithful pastor of a flock is successor to the apostles in every thing in which they were to have any successors. In the apostolic office there were indeed some things peculiar and extraordinary, such as their immediate call by Christ, their infallibility, their being witnesses of our Lord's resurrection, and their unlimited jurisdiction over the whole world. These powers and privileges could not be conveyed by imposition of hands to any successors, whether called presbyters or bishops; but as rulers or office-bearers in particular churches, we have the confession of "the very chiefest apostles," Peter and John, that they were nothing more than presbyters or parish ministers. This being the case, the dispute, which in the early part of the passing century was so warmly agitated concerning the validity of Presbyterian ordination, may be soon decided; for if the ceremony of ordination be at all essential, it is obvious that such a ceremony performed by presbyters must be valid, as there is no higher order of ecclesiastics in the church by whom it can be performed. Accordingly we find, that Timothy himself, though said to be a bishop, was ordained by the laying on of the hands of a presbytery. At that ordination indeed St Paul presided, but he could preside only as *primus in paribus;* for we have seen that, as permanent officers in the church of Christ, the apostles themselves were no more than presbyters. If the apostles hands were imposed for any other purpose, it must have been to communicate those *charismata* or miraculous gifts of the Holy Spirit, which were then so frequent; but which no modern presbyter or bishop will pretend to give, unless his understanding be clouded by the grossest ignorance, or perverted by the most frantic enthusiasm.

8 Rise of episcopacy.

But if the office of bishop and presbyter was originally the same, how, it will be asked, came diocesan episcopacy to prevail so universally as it is confessed to have done before the conversion of Constantine and the civil establishment of Christianity in the Roman empire? To give a satisfactory answer to this question is certainly the most arduous task which the advocate for presbytery has to perform; but it is a task not insurmountable.

From many passages in the New Testament *, it is evident, that when the apostles planted churches in different cities, they generally settled more than one pastor in the same church, to feed and govern it with joint authority. The propriety of this constitution is obvious. In those days, when the disciples of Christ were persecuted for their religion, and often obliged to meet in the "night for fear of the Jews," they could not with any degree of prudence assemble in large numbers; and therefore, had there been no more than one pastor in a city, the Christian converts, though, when assembled, they might have amounted to but a small congregation, could not all have enjoyed the benefit of public worship on the same day; at least it is obvious that they could not possibly have assembled for this purpose so often as their want of instruction, and the duty of "breaking of bread and of prayer," required them to meet. It was therefore with great wisdom that the apostles ordained several presbyters in the same church; but as these presbyters would have occasion to meet frequently, and to deliberate on the state of the flock which it was their duty to feed, and over which they had all equal authority, they would be under the necessity of electing one of their own

* Acts xi. 29. xiii. 1, 2, 3. xv. Tit. i. 5.

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number to be president or *moderator* of the presbytery, that order might be preserved, and all things done with decency. At first there is reason to believe that those presidents held their office no longer than while the presbyteries sat in which they were elected. Among the apostles themselves there was no fixed president. Peter indeed appears to have been most frequently admitted to that honour; but there is one very memo-
† Acts xv. rable occasion on record †, when James the Lord's brother presided in an assembly of apostles, elders, and brethren, held at Jerusalem, to determine the question concerning the necessity of circumcising the Gentiles, and commanding them to keep the law of Moses.

Upon this model were the primitive presbyteries formed. They consisted of several presbyters possessed of equal powers, who at their meetings appointed one of their own number to discharge the office of moderator or temporary president; but to this president they gave no prelatical powers or negative voice over the deliberations of his brethren; for, as Jerome informs us,
9 According to Jerome. the church was then governed *communi presbyterorum concilio*, "by a common council of presbyters." It appears, however, that when an apostle, an apostolical man, or an evangelist, fixed his residence in any city, and took upon himself the pastoral care of part of the flock, his co-presbyters, from respect to his singular gifts, made him their constant and fixed moderator. Hence Timothy, during his abode at Ephesus, was moderator of the presbytery; and hence too Mark the evangelist, who resided many years in Alexandria, has been called the first bishop of that church, though he appears to have been nothing more than permanent moderator. We advance this upon the authority of Jerome, one of the most learned fathers of the Christian church, who informs us, that upon the death of the evangelist, the presbyters of Alexandria, for more than 200 years, chose their bishops from their own number, and placed them in the episcopal chair, without dreaming that they ought to be raised to a higher order by a new consecration;—*Presbyteri unum ex se electum in excelsiori gradu collocatum, episcopum nominabant.* As this practice of making the moderator of the presbytery of Alexandria a permanent officer, was thought a good expedient to guard the infant churches against schisms and divisions, those churches gradually adopted it. For, as Jerome tells us, *Postquam unusquisque eos quos baptizaverat, suos putabat esse, non Christi, in toto orbe decretum est, ut unus de presbyteris electus, superponeretur cæteris, ad quem omnis ecclesiæ cura pertineret, et schismatum semina tollerentur.*

The advantages which, in displaying his talents and authority, the perpetual president or speaker of any assembly has over his colleagues in office, are so obvious, that when the practice of electing their moderators for life became universal among the presbyteries of the primitive church, it is easy to conceive how ambitious men might so magnify the difficulties and importance of their station, as to introduce the custom of filling it by a new consecration of the bishop elect. But when this was done, diocesan episcopacy, with all its powers and prerogatives, would follow as a thing of course, until "by little and little (as Jerome expresses himself) the whole pastoral care of the flock was devolved upon one man."

Our limits will not permit us to trace more minutely the rise and progress of this ecclesiastical usurpation, as the Presbyterian calls it; but the reader who wishes for fuller information, after studying the remains of the four first centuries of the Christian church, may consult *An Inquiry into the Constitution, Discipline, and Worship, of the Primitive Church*, said to have been written by Sir Peter King, afterwards lord chancellor of England. As an impartial lover of truth, he will do well to consult also a book intitled *An original Draught of the Primitive Church*, which was published as an answer to the Inquiry; and he may read with much advantage to himself *A Letter from a parochial bishop to a prelatical gentleman*, with *An Apology for the church of Scotland*, both written by Mr Willison some time minister in Dundee, and both evincing considerable learning and great ingenuity in their pious author.

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10 The church of Scotland

Of the churches at present formed upon this model, we believe, that without incurring the imputation of national prejudice, we may safely affirm the church of Scotland to be by much the most respectable. Her mode of worship is simple and solemn; her established faith agreeable to the confessions of most other Protestant churches; her judicatories are calculated to maintain the rights of the people; and her pastors are confessedly men of liberal and enlightened minds. On these accounts it appears to us, that we cannot more properly conclude this article than with a short view of her constitution, as being that in which our Presbyterian readers are undoubtedly most interested.

No one is ignorant, that from the first dawn of reformation among us, till the era of the revolution, there was a perpetual struggle between the court and the people for the establishment of an Episcopal or a Presbyterian form of church government: The former model of ecclesiastical polity was patronised by the house of Stuart on account of the support which it gave to the prerogatives of the crown; the latter was the favourite of the majority of the people, perhaps not so much on account of its superior claim to apostolical institution, as because the laity are mixed with the clergy in church judicatories, and the two orders, which under episcopacy are kept so distinct, incorporated, as it were, into one body. In the Scottish church, every regulation of public worship, every act of discipline, and every ecclesiastical censure, which in other churches
11 Governed by clergymen and laymen. flows from the authority of a diocesan bishop, or from a convocation of the clergy, is the joint work of a certain number of clergymen and laymen acting together with equal authority, and deciding every question by a plurality of voices. The laymen who thus form an essential part of the ecclesiastical courts of Scotland, are called *ruling elders*; and hold the same office, as well as the same name, with those brethren * who joined * Acts xv. with the apostles and elders at Jerusalem in determining the important question concerning the necessity of imposing upon the Gentile converts the ritual observances of the law of Moses. These lay-elders Paul enjoined Timothy § to account worthy of double honour, § 1 Tim. v. if they should rule well, and discharge the duties for 17. which they were separated from the multitude of their brethren. In the church of Scotland every parish has two or three of those lay-elders, who are grave and serious persons chosen from among the heads of families, of known orthodoxy and steady adherence to the worship, discipline, and government of the church. Being

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ing solemnly engaged to use their utmost endeavours for the suppression of vice and the cherishing of piety and virtue, and to exercise discipline faithfully and diligently, the minister, in the presence of the congregation, sets them apart to their office by solemn prayer; and concludes the ceremony, which is sometimes called ordination, with exhorting both elders and people to their respective duties.

12 The kirk-session.

The kirk-session, which is the lowest ecclesiastical judicatory, consists of the minister and those elders of the congregation. The minister is *ex officio* moderator, but has no negative voice over the decision of the session; nor indeed has he a right to vote at all, unless when the voices of the elders are equal and opposite. He may indeed enter his protest against their sentence, if he think it improper, and appeal to the judgment of the presbytery; but this privilege belongs equally to every elder, as well as to every person who may believe himself aggrieved by the proceedings of the session. The deacons, whose proper office it is to take care of the poor, may be present in every session, and offer their counsel on all questions that come before it; but except in what relates to the distribution of alms, they have no decisive vote with the minister and elders.

13 The presbytery.

The next judicatory is the *presbytery*, which consists of all the pastors within a certain district, and one ruling elder from each parish commissioned by his brethren to represent, in conjunction with the minister, the session of that parish. The presbytery treats of such matters as concern the particular churches within its limits; as the examination, admission, ordination, and censuring of ministers; the licensing of probationers, rebuking of gross or contumacious sinners, the directing of the sentence of excommunication, the deciding upon references and appeals from kirk-sessions, resolving cases of conscience, explaining difficulties in doctrine or discipline; and censuring, according to the word of God, any heresy or erroneous doctrine which hath been either publicly or privately maintained within the bounds of its jurisdiction. Partial as we may be thought to our own church, we frankly acknowledge that we cannot altogether approve of that part of her constitution which gives an equal vote, in questions of heresy, to an illiterate mechanic and his enlightened pastor. We are persuaded that it has been the source of much trouble to many a pious clergyman; who, from the laudable desire of explaining the scriptures and declaring to his flock all the counsel of God, has employed a variety of expressions of the same import, to illustrate those articles of faith, which may be obscurely expressed in the established standards. The fact however is, that, in presbyteries, the only prerogatives which the pastors have over the ruling elders, are the power of ordination by imposition of hands, and the privilege of having the moderator chosen from their body.

14 The provincial synod.

From the judgment of the presbytery there lies an appeal to the provincial synod, which ordinarily meets twice in the year, and exercises over the presbyteries within the province a jurisdiction similar to that which is vested in each presbytery over the several kirk-sessions within its bounds. Of these synods there are in the church of Scotland fifteen, which are composed of the members of the several presbyteries within the respective provinces which give names to the synods.

The highest authority in the church of Scotland is the general assembly, which consists of a certain number of ministers and ruling elders delegated from each presbytery, and of commissioners from the universities and royal boroughs. A presbytery in which there are fewer than twelve parishes, sends to the general assembly two ministers and one ruling elder: if it contain between 12 and 18 ministers, it sends three of these, and one ruling elder: if it contain between 18 and 24 ministers, it sends four ministers and two ruling elders; and of 24 ministers, when it contains so many, it sends five with two ruling elders. Every royal borough sends one ruling elder, and Edinburgh two; whose election must be attested by the kirk-sessions of their respective boroughs. Every university sends one commissioner from its own body. The commissioners are chosen annually six weeks before the meeting of the assembly; and the ruling elders are often men of the first eminence in the kingdom for rank and talents. In this assembly, which meets once a year, the king presides by his commissioner, who is always a nobleman; but he has no voice in their deliberations. The order of their proceedings is regular, though sometimes the number of members creates a confusion, which the moderator, who is chosen from among the ministers to be, as it were, the speaker of the house, has not sufficient authority to prevent. Appeals are brought from all the other ecclesiastical courts in Scotland to the general assembly; and in questions purely religious no appeal lies from its determinations. —In the subordination of these assemblies, parochial, presbyterial, provincial, and national, the less unto the greater, consists the external order, strength, and stedfastness of the church of Scotland.

Presbyterians || Prescription.

15 The general assembly.

PRESCIENCE, in theology, prevision, or foreknowledge; that knowledge which God has of things to come.—The doctrine of predestination is founded on the prescience of God, and on the supposition of all futurity's being present to him. See PREDESTINATION.

PRESCRIPTION, in medicine, is the assigning a proper and adequate remedy to the disease, from an examination of its symptoms, and an acquaintance with the virtues and effects of the materia medica.

PRESCRIPTION, in law, is a title acquired by use and time, and allowed by law; as when a man claims any thing, because he, his ancestors, or they whose estate he hath, have had or used it all the time whereof no memory is to the contrary: or it is where for continuance of time, *ultra memoriam hominis*, a particular person hath a particular right against another.

There is a difference between prescription, custom, and usage. *Prescription* hath respect to a certain person, who *by intendment* may have continuance *for ever*; as for instance, he and all they *whose estate he hath* in such a thing, this is a prescription: but, *Custom* is *local*, and always applied to a *certain* place; as, *time out of mind there has been such a custom in such a place*, &c. And *prescription* belongeth to *one* or a *few* only; but *custom* is common to *all*. *Usage* differs from both, for it may be either to *persons* or *places*; as to *inhabitants of a town to have a way*, &c.

A custom and prescription are in the *right*; usage is in the *possession*; and a prescription that is good for the matter and substance, may be bad by the manner of setting it forth: but where that which is claimed *as a custom*, in or for many, will be good, *that* regularly will be so when claimed by *prescription* for one. *Prescription* is to

be

Prescription || Presentation.

be *time out of mind;* though it is not the length of time that begets the right of prescription, nothing being done by time, although every thing is done in time; *but it is a presumption in law, that a thing cannot continue so long quiet, if it was against right, or injurious to another.*

PRESCRIPTION, in Scotch law. See LAW, p. 698, and 725.

PRESCRIPTION, in theology, was a kind of argument pleaded by Tertullian and others in the 3d century against erroneous doctors. This mode of arguing has been despised by some, both because it has been used by Papists, and because they think that truth has no need of such a support. But surely in disputed points, if it can be shown that any particular doctrine of Christianity was held in the earliest ages, even approaching the apostolic, it must have very considerable weight; and indeed that it has so, appears from the universal appeals of all parties to those early times in support of their particular opinions. Besides, the thing is in itself natural; for if a man finds a variety of opinions in the world upon important passages in scripture, where shall he be so apt to get the true sense as from cotemporary writers or others who lived very near the apostolic age? and if such a man shall find any doctrine or interpretation to have been universally believed in the first ages, or as Vincentius Lirinensis words it, *semper ubique et ab omnibus*, he will unquestionably be disposed to think such early and universal consent, or such prescription, of very considerable weight in determining his opinion.

PRESENCE, a term of relation, used in opposition to absence, and signifying the existence of a person in a certain place.

PRESENT Tense, in grammar, the first tense of a verb, expressing the present time, or that something is now performing; as *scribo*, I write, or am writing. See GRAMMAR.

PRESENTATION, in ecclesiastical law. See PATRONAGE.

PRESENTATION of the Virgin, is a feast of the Romish church, celebrated on the 21st of November, in memory of the Holy Virgin's being presented by her parents in the temple, to be there educated. Emanuel Comnenus, who began to reign in 1143, makes mention of this feast in his Constitution. Some imagine it to have been established among the Greeks in the 11th century; and think they see evident proofs of it in some homilies of George of Nicomedia, who lived in the time of Photius. Its institution in the West is ascribed to Gregory XI. in 1372. Some think it was instituted in memory of the ceremony practised among the Jews for their newborn females; corresponding to the circumcision on the eighth day for males.

PRESENTATION of our Lady also gives the title to three orders of nuns. The first, projected in 1618, by a maid named Joan of Cambray. The habit of the nuns, according to the vision she pretended to have, was to be a grey gown of natural wool, &c.; but this project was never accomplished. The second was established in France, about the year 1627, by Nicholas Sanguin, bishop of Senlis; it was approved by Urban VIII. This order never made any great progress. The third was established in 1664, when Frederic Borromeo, being apostolical visitor in the Valteline, was intreated by some devout maids at Morbegno to allow them to live in community in a retired place; which he granted, and erected them into a congregation, under the title of *congregation of our Lady*. They live under the rule of St Augustine.

Presentment || Press.

PRESENTMENT, in law. See PROSECUTION.

A presentment, generally taken, is a very comprehensive term; including not only *presentments* properly so called, but also inquisitions of office, and indictments by a grand jury. A presentment, properly speaking, is the notice taken by a grand jury of any offence from their own knowledge or observation, without any bill of indictment laid before them at the suit of the king: As the presentment of a nuisance, a libel, and the like; upon which the officer of the court must afterwards frame an indictment, before the party presented can be put to answer it. An inquisition of office is the act of a jury, summoned by the proper officer to inquire of matters relating to the crown, upon evidence laid before them. Some of these are in themselves convictions, and cannot afterwards be traversed or denied; and therefore the inquest, or jury, ought to hear all that can be alleged on both sides. Of this nature are all inquisitions of *felo de se;* of flight in persons accused of felony; of deodands, and the like; and presentments of petty offences in the sheriff's tourn or court-leet, whereupon the presiding officer may set a fine. Other inquisitions may be afterwards traversed and examined; as particularly the coroner's inquisition of the death of a man, when it finds any one guilty of homicide; for in such cases the offender so presented must be arraigned upon this inquisition, and may dispute the truth of it; which brings it to a kind of indictment, the most usual and effectual means of prosecution. See INDICTMENT.

PRESIDENT, PRÆSES, is an officer created or elected to preside over a company or assembly; so called in contradistinction to the other members, who are termed *residents*.

Lord PRESIDENT of the Council, is a great officer of the crown, who has precedence next after the lord chancellor and lord treasurer; as ancient as the time of King John, when he was styled *consiliarius capitalis*.—His office is to attend on the king, to propose business at the council-table, and to report to the king the several transactions there. See *PRIVY-Council*.

PRESIDIAL, was a tribunal, or bench of judges, established (before the Revolution) in the several considerable cities of France, to judge ultimately, or in the last resort, of the several causes brought before them by way of appeal from the subaltern judges. The presidials made one company with the officers of the bailliages and seneschaussees, where they were established.

PRESS (PRELUM), in the mechanic arts, a machine made of iron or wood, serving to squeeze or compress any body very close.

The ordinary presses consist of six members, or pieces; viz. two flat smooth planks; between which the things to be pressed are laid; two screws, or worms, fastened to the lower plank, and passing through two holes in the upper; and two nuts, in form of an S, serving to drive the upper plank, which is moveable, against the lower, which is stable, and without motion.

PRESSES used for expressing of Liquors, are of various kinds; some, in most respects, the same with the common presses, excepting that the under plank is perforated

Preſs. forated with a great number of holes, to let the juice expreſſed run through into a tub, or receiver, underneath.

A very uſeful machine for a preſs, in the proceſs of cyder-making, has been lately conſtructed by Mr Anſtice, who, with his well-known zeal for the improvement of mechanics, permits us to lay before our readers the following deſcription of it.

Plate CCCCXV. AA, n° 1. two pieces of timber, 21 feet long, 12 by 6 inches, laid ſide by ſide at the diſtance of 12 inches, and ſecured in that ſituation by blocks placed between and bolts paſſing through them; this frame forms the bed of the machine. BB, two uprights, 12 feet long, 6 by 8 inches, morticed upon them, and ſecured in their poſition by pins and iron ſquares. CC, two uprights, five feet long, ſix by 10 inches, morticed near the end of the under frame, and ſecured as before. D, a lever, 17 feet long, 12 by 13 inches, turning on a large bolt which paſſes through the ſhort uprights, alſo through iron ſtraps, which ſecure them to the bed inſide, and a ſtirrup of iron which paſſes over the end of the lever, and which makes the turning point in the line of its lower ſide, and not through its middle. E, a lever 20 feet long, ſix by eight inches at its largeſt part, and tapering towards the other end: this lever turns on a bolt in the uprights BB. F, 1, 2, 3, 4. four pieces of oak (which he calls *needles*, 10 feet long), four by two and an half inches, morticed looſely into the upper lever, and hung thereto by bolts, ſo as to ſwing perpendicularly, and play in a long mortice or channel cut through the large lever to receive them. Theſe needles have inch-holes pretty cloſely bored through them (in a direction croſſing the machine), from the lower ends, as far upwards as the great lever will reach, when it is as high as it can go. G, a bed to receive what is to be preſſed. H, a frame to ſupport a winch worked by a handle at I. At the end of the ſmall lever two blocks or pulleys are fixed, one above, and the other below it; a rope of about half an inch diameter is then faſtened to the cieling (or continuation of the uprights of the winch frame if neceſſary) at K; then paſſed through the upper block on the lever, from thence paſſed through a block at L, and then goes with four turns round the winch, from whence it is carried through the block under the lever, and faſtens to the machine at M; by this means, if the winch be turned one way, it raiſes the end of the ſmall lever if the other depreſſes it.

To work the machine. If we ſuppoſe the great lever bearing on the matter to be preſſed, an iron pin muſt be put into one of the holes in the needles above the great lever; and when the ſmall lever is worked as far as it will go, either up or down, another bolt is to be put into the hole, which comes neareſt above the great lever on the other ſide of the uprights BB, and the winch then turned the contrary way, by which means the preſſing goes on whether the ſmall lever riſes or falls. Before the reſiſtance is very great, the needles fartheſt from the fulcrum of the ſmall lever are uſed; after that the neareſt are employed, which doubles the power of the machine. In raiſing the great lever, or lowering it to its bearing, the needles moſt diſtant from the fulcrum of the ſmall lever, are uſed *under* inſtead of *over* it. As the rope is liable to ſtretch and get ſlack, he paſſes it, after taking two turns on the winch, through a pulley, to which is ſuſpended a weight of half a hundred, and then takes two turns more before it is carried through the other block, by which means the ſlack is conſtantly gathered in, and the weight holds on without increaſing the friction, as by hanging under the winch it counteracts the preſſure upwards on its axis. Preſs.

The power of this machine is very great, being as 1 to 1136 nearly, and capable by a trifling addition of any other proportion. It is applicable to many purpoſes beſide cyder-preſſing, and is more ſimple, and leſs liable to injury, than any other which has fallen under our obſervation. Perhaps, however, it would be an improvement to uſe, inſtead of the ropes and pulleys, by which the lever E is moved, a ſmall wheel or pinion of 10 or 12 teeth, on the axis of the winch W (n° 2.), and a ſtiff beam *e n* down from the lever, having on its lower end an iron rack, of which the teeth take into thoſe of the pinion. The action of theſe teeth would, in our opinion, be leſs diminiſhed by friction and obliquity, than the pulleys are by friction and the ſtiffneſs of the rope; and the machine would retain all its other advantages.

Press uſed by Joiners, to keep cloſe the pieces they have glued, eſpecially panels, &c. of wainſcot, is very ſimple, conſiſting of four members; viz. two ſcrews, and two pieces of wood, four or five inches ſquare, and two or three feet long; whereof the holes at the two ends ſerve for nuts to the ſcrews.

Press uſed by Inlayers, reſembles the joiner's preſs, except that the pieces of wood are thicker, and that only one of them is moveable; the other, which is in form of a treſſel, being ſuſtained by two legs or pillars, jointed into it at each end. This preſs ſerves them for ſawing and cleaving the pieces of wood required in marquetry or inlaid work.

Founder's Press, is a ſtrong ſquare frame, conſiſting of four pieces of wood, firmly joined together with tenons, &c. This preſs is of various ſizes, according to the ſizes of the moulds; two of them are required to each mould, at the two extremes whereof they are placed; ſo as that, by driving wooden wedges between the mould and the ſides of the preſſes, the two parts of the mould wherein the metal is to be run may be preſſed cloſe together.

Printing-Press. See *Printing-Preſs*.

Rolling-Press, is a machine uſed for the taking off prints from copper-plates. It is much leſs complex than that of the letter-printers. See its deſcription and uſe under the article *Rolling-preſs Printing*.

Press, in *Coining*, is one of the machines uſed in ſtriking of money; differing from the balance, in that it has only one iron bar to give it motion, and preſs the moulds or coins; is not charged with lead at its extreme, nor drawn by cordage. See Coining.

Binder's Cutting-Press, is a machine uſed equally by book-binders, ſtationers, and paſteboard-makers; conſiſting of two large pieces of wood, in form of cheeks, connected by two ſtrong wooden ſcrews; which, being turned by an iron bar, draw together, or ſet aſunder, the cheeks, as much as is neceſſary for the putting in the books or paper to be cut. The cheeks are placed lengthwiſe on a wooden ſtand, in the form of a cheſt, into which the cuttings fall. Aſide of the cheeks are two pieces of wood, of the ſame length with the ſcrews, ſerving to direct the cheeks, and prevent their opening unequally.

Preſs, Preſſing.

unequally. Upon the cheeks the plough moves, to which the cutting-knife is faſtened by a ſcrew; which has its key, to diſmount it, on occaſion, to be ſharpened.

The plough conſiſts of ſeveral parts; among the reſt a wooden ſcrew or worm, which, catching within the nuts of the two feet that ſuſtain it on the cheeks, brings the knife to the book or paper which is faſtened in the preſs between two boards. This ſcrew, which is pretty long, has two directories, which reſemble thoſe of the ſcrews of the preſs. To make the plough ſlide ſquare and even on the cheeks, ſo that the knife may make an equal paring, that foot of the plough where the knife is not fixed, ſlides in a kind of groove, faſtened along one of the cheeks. Laſtly, the knife is a piece of ſteel, ſix or ſeven inches long, flat, thin, and ſharp, terminating at one end in a point, like that of a ſword, and at the other in a ſquare form, which ſerves to faſten it to the plough. See *Book-Binding*.

As the long knives uſed by us in the cutting of books or papers, are apt to jump in the cutting thick books, the Dutch are ſaid to uſe circular knives, with an edge all round; which not only cut more ſteadily, but laſt longer without grinding.

PRESS, in the *Woollen Manufactory*, is a large wooden machine, ſerving to preſs cloths, ſerges, rateens, &c. thereby to render them ſmooth and even, and to give them a gloſs.

This machine conſiſts of ſeveral members; the principal whereof are the cheeks, the nut, and the worm or ſcrew, accompanied with its bar, which ſerves to turn it round, and make it deſcend perpendicularly on the middle of a thick wooden plank, under which the ſtuffs to be preſſed are placed. The CALENDER is alſo a kind of preſs, ſerving to preſs or calender linens, ſilks, &c.

Liberty of the PRESS. See *Liberty of the Preſs*.

PRESSING, in the manufactures, is the violently ſqueezing a cloth, ſtuff, &c. to render it ſmooth and gloſſy.

There are two methods of preſſing, viz. cold and hot.

As to the former, or cold preſſing: After the ſtuff has been ſcoured, fulled, and ſhorn, it is folded ſquare in equal plaits, and a ſkin of vellum or paſteboard put between each plait. Over the whole is laid a ſquare wooden plank, and ſo put into the preſs, which is ſcrewed down tight by means of a lever. After it has lain a ſufficient time in the preſs, they take it out, removing the paſteboards, and lay it up to keep. Some only lay the ſtuff on a firm table after plaiting and paſteboarding, cover the whole with a wooden plank, and load it with a proper weight.

The method of preſſing hot is this: When the ſtuff has received the above preparations, it is ſprinkled a little with water, ſometimes gum-water; then plaited equally, and between each two plaits are put leaves of paſteboard; and between every ſixth and ſeventh plait, as well as over the whole, an iron or braſs plate well heated in a kind of furnace. This done, it is laid upon the preſs, and forcibly ſcrewed down. Under this preſs are laid five, ſix, &c. pieces at the ſame time, all furniſhed with their paſteboards and iron-plates. When the plates are well cooled, the ſtuffs are taken out and ſtitched a little together to keep them in the plaits. This manner of preſſing was only invented to cover the defects of the ſtuffs; and, accordingly, it has been frequently prohibited.

Preſſing, || Preſteign.

PRESSING, or *Impreſſing*. See IMPRESSING.

PRESSION, or PRESSURE, in the Carteſian Philoſophy, is a ſuppoſed impulſive kind of motion, or rather an endeavour to move, impreſſed on a fluid medium, and propagated through it.

PRESSURE OF AIR. See PNEUMATICS.

Pressure of Fluids. See HYDROSTATICS and PNEUMATICS.

PREST, is uſed for a duty in money, to be paid by the ſheriff on his account, in the exchequer, or for money left or remaining in his hands: 2 & 3 Edw. VI. c. 4.

Prest-Money, is ſo called from the French word *preſt*, that is, *promptus, expeditus*; for that it binds thoſe who receive it, to be ready at all times appointed, being commonly meant of ſoldiers.

PRESTATION-MONEY, is a ſum of money paid yearly by archdeacons and other dignitaries to their biſhop, *pro exteriori juriſdictione*.

PRESTATION (*præſtatio*), was anciently uſed for other payments: *Et quieti ſint de præſtatione muragii*. Chart. Hen. VII. Sometimes alſo for pourveyance.

PRESTEIGN is a town in Radnorſhire, diſtant 149 miles weſt-north-weſt from London, in the direct road to Aberyſtwith, and throughout South Wales, in N. Lat. 52° 12′, bounded to the north and north-eaſt by Herefordſhire. It is a neat well built town, with clean and regular ſtreets, and is the reſidence of many genteel families. The neighbourhood abounds with all the comforts and conveniencies of life. It is ſeated on a gravelly ſoil on the banks of the river Lug, and at the head of a very fertile vale: the mountains to the weſt and north-weſt of the town forming, as it were, an amphitheatre round it. The name of it in Welſh is *Slan-Andras*, which is ſuppoſed to be derived from the church, which is dedicated to Saint Andrew. The town is divided into four wards, which have each a ſeparate juriſdiction, ſeparate officers, levies, &c. The curfew-bell of William the Conqueror ſtill remains in this place, and is rung every night. It is a borough by preſcription, and is governed by a bailiff annually elected, and ſworn in by a ſteward appointed by the crown. The living is a rectory and vicarage united, and reported to be worth from L. 500 to L. 600 *per annum*; the pariſh lying in two counties. Here is an excellent free ſchool well endowed. The county hall, the county gaol, the county bridewell, and houſe of correction, are kept in this place. The markets are held on Saturdays; and there are two fairs in the year. About a century and a half ago Preſteign was conſiderably larger; had a good woollen manufactory, of which the very large buildings now ſtanding (formerly belonging to clothiers) bear ample teſtimony; but a fire, ſucceeded by the plague, in the town about the year 1636, reduced the ſame, and with it, its conſequence as a manufacturing town. The healthineſs of its ſituation cannot be better aſcertained than by the regiſter of births and burials. The pariſh embraces at leaſt a circle of 19 miles; and the average of burials for the laſt ſeven years was only 26 perſons *per annum*, and that of births for the ſame time was 42; and of the former upwards of 18 were from 80 to 100 years old.

PRES-

Prester
Preterition

PRESTER (John, or Jean), an appellation formerly given to an emperor of the Tartars who was overcome and killed by Jenghiz Khan. Since that time it has been given to the emperor of Abyſſinia or Ethiopia; however, in Ethiopia itſelf this name is utterly unknown, the emperor being there called the *grand negus*.

PRESTER, a meteor, conſiſting of an exhalation thrown from the clouds downwards with ſuch violence, as that by the colliſion it is ſet on fire. The word is Greek, πρηστης, the name of a kind of ſerpent; called alſo *dipſas*, to which this meteor is ſuppoſed to bear a reſemblance. The preſter differs from the thunderbolt in the manner of its inflammation; and in its burning and breaking every thing it touches with greater violence.

PRESTER, a word uſed by ſome to expreſs the external part of the neck, which is uſually inflated in anger.

PRESTIMONY, in canon law, is derived *a præſtatione quotidiana*; and is, by ſome, defined to be a kind of benefice, ſerved by a ſingle prieſt. Others ſay, it is the incumbency of a chapel, without any title or collation; ſuch as are moſt of thoſe in caſtles, where prayers or maſs are ſaid; and which are mere unendowed oratories. Whence the term is alſo applied, in the Romiſh church, to certain perpetual offices beſtowed on canons, religious, or others, for the ſaying of maſſes, by way of augmentation of their livings. Others think it is a leaſe, or conceſſion of any eccleſiaſtical fund or revenue, belonging to a monaſtery, to be enjoyed during life. Du Moulin calls it a *profane benefice*, which, however, has a perpetual title, and an eccleſiaſtical office, with certain revenues attached to it; which the incumbent is allowed to ſell, and which may be poſſeſſed without tonſure; ſuch as the lay church-wardens of Notre-dame. He adds, that, in propriety, the canonries of chapels are benefices of this nature. The moſt probable opinion ſeems to be, that preſtimony is a fund, or revenue, appropriated by the founder for the ſubſiſtence of a prieſt, without being erected into any title of benefice, chapel, prebend, or priory; and which is not ſubject either to the pope or to the ordinary, but whereof the patron, and thoſe who have a right from him, are the collators, and nominate and confer *pleno jure*.

PRESTO, in the Italian muſic, intimates to perform quick; as *preſtiſſimo* does extremely quick.

PRESTON, a town of Lancaſhire in England, ſeated on the river Ribble, over which there is a handſome ſtone bridge. Here is held a court of chancery, and other offices of juſtice for the county palatine of Lancaſter. It is noted for the defeat of the rebels here in 1715, when they were all made priſoners, and ſent up to London. W. Long. 2. 26. N. Lat. 53. 45.

PRESTRE. See VAUBAN.

PRETENSED or PRETENDED right, in law, is where one is in poſſeſſion of lands and tenements, which another, who is out, claims and ſues for. Here the pretenſed right is in him who ſo claims or ſues.

PRETERITE, in grammar, a tenſe which expreſſes the time paſt, or an action completely finiſhed; as, *ſcripſi*, "I have written." See PERFECT and GRAMMAR.

PRETERITION, or PRETERMISSION, in rhetoric, a figure whereby, in pretending to paſs over a thing untouched, we make a ſummary mention thereof. *I will not ſay he is valiant, he is learned, he is juſt*, &c. The moſt artful praiſes are thoſe given by way of preterition. See ORATORY.

Preter
Priam.

PRETEXT, a colour or motive, whether real or feigned, for doing ſomething.

TOGA PRETEXTA, among the ancient Romans, a long white gown, with a border of purple round the edges, and worn by children of quality till the age of puberty, *viz.* by the boys till 17, when they changed it for the *toga virilis*: and by the girls till marriage.

PRETIUM SEPULCHRI, in old law books, &c. thoſe goods accruing to the church wherein a corpſe is buried. In the Iriſh canons, lib. xix. cap. 6. it is ordered, that along with every body that is buried, there go his cow, horſe, apparel, and the furniture of his bed; none of which may be diſpoſed of otherwiſe than for the payment of debts, &c. as being familiars and domeſtics of the deceaſed.

PRETOR, a magiſtrate among the ancient Romans, not unlike our lord chief juſtices, or lord chancellor, or both in one; as being veſted with the power of diſtributing juſtice among the citizens. At firſt there was only one pretor; but afterwards, another being created, the firſt or chief one had the title of *prætor urbanus*, or the "city pretor:" the other was called *peregrinus*, as being judge in all matters relating to foreigners. But, beſides theſe, there were afterwards created many provincial pretors; who were not only judges, but alſo aſſiſted the conſuls in the government of the provinces, and even were inveſted with the government of provinces themſelves.

PRETORIAN GUARDS, in Roman antiquity, were the emperor's guards, who at length were increaſed to 10,000: they had this denomination, according to ſome, from their being ſtationed at a place called *Prætorium*: their commander was ſtyled *præfectus prætorii*.

PRETORIUM, or PRÆTORIUM, among the Romans, denoted the hall or court wherein the pretor lived, and wherein he adminiſtered juſtice.

It likewiſe denoted the tent of the Roman general, wherein councils of war, &c. were held: alſo a place in Rome where the Pretorian guards were lodged.

PREVARICATION, in the civil law, is where the informer colludes with the defendants, and ſo makes only a ſham proſecution.

PREVARICATION, in our laws, is when a man falſely ſeems to undertake a thing, with intention that he may deſtroy it; where a lawyer pleads booty, or acts by colluſion, &c.

It alſo denotes a ſecret abuſe committed in the exerciſe of a public office, or of a commiſſion given by a private perſon.

PRIAM, king of Troy, was the ſon of Laomedon. He was carried into Greece after the taking of that city by Hercules; but was afterwards ranſomed, on which he obtained the name of *Priam*, a Greek word ſignifying "ranſomed." At his return he rebuilt Ilium, and extended the bounds of the kingdom of Troy, which became very flouriſhing under his reign. He married Hecuba, the daughter of Ciſſeus king of Thrace, by whom he had 19 children; and among the reſt Paris,

Priapiſmus || Price.

who carried off Helen, and occaſioned the ruin of Troy, which is ſuppoſed to have been ſacked by the Greeks about 1184 B. C. when Priam was killed by Pyrrhus the ſon of Achilles at the foot of an altar where he had taken refuge, after a reign of 52 years. See TROY.

PRIAPISMUS, or PRIAPISM, is an erection of the penis without any concomitant pain, or the conſent of other parts. It is thus called, becauſe the perſon in this ſtate reſembles the lewd god Priapus. Cœlius Aurelianus ſays it is a palſy of the ſeminal veſſels, and other nerves diſtributed to the parts about the penis, by the diſtenſion of which this diſorder is produced. It is of the ſame nature as the ſatyriaſis. See MEDICINE, n° 372.

PRIAPUS, in Pagan worſhip, the ſon of Bacchus and Venus, who preſided over gardens and the moſt indecent actions.] He was particularly adored at Lampſacus, a city at the mouth of the Helleſpont, ſaid to be the place of his birth; and his image was placed in gardens to defend them from thieves and birds deſtructive to fruit. He was uſually repreſented naked, with a ſtern countenance, matted hair, and holding either a wooden ſword or ſickle in his hand, and with a monſtrous privity; from whence downward his body ended in a ſhapeleſs trunk. The ſacrifice offered to this obſcene deity was the aſs; either on account of the natural uncomelineſs of this animal, and its propenſity to venery, or from the diſappointment which Priapus met with on his attempting the chaſtity of Veſta, while that goddeſs was aſleep, when ſhe eſcaped the injury deſigned her by her being awaked by the braying of old Silenus's aſs.

PRICE (Rev. Richard), D. D. L. L. D. fellow of the Royal Society of London, and of the Academy of Sciences, New England, was born at Tynton in Glamorganſhire, February 22. 1723. His father was a diſſenting miniſter at Bridgend in that county, and died in 1739. At eight years old he was placed under a Mr Simmons of Neath; and in four years removed to Pentwyn in Caermarthenſhire under the Rev. Samuel Jones, whom he repreſented as a man of a very enlarged mind, and who firſt inſpired him with liberal ſentiments of religion. Having lived as long with him as with Mr Simmons, he was ſent to Mr Griffith's academy at Talgarth in Breconſhire. In 1740 he loſt his mother; and on this he quitted the academy and came to London. Here he was ſettled at that academy, of which Mr Eames was the principal tutor, under the patronage of his uncle the Rev. S. Price, who was copaſtor with Dr Watts upwards of 40 years. At the end of four years he left this academy, and reſided with Mr Streatfield of Stoke Newington in the quality of domeſtic chaplain, while at the ſame time he regularly aſſiſted Dr Chandler at the Old Jewry, and occaſionally aſſiſted others. Having lived with Mr Streatfield near 13 years, on his death and his uncle's he was induced to change his ſituation, and in 1757 married Miſs S. Blundell of Leiceſterſhire. He then ſettled at Hackney, but being ſhortly after choſen miniſter at Newington Green, he lived there until the death of his wife, which was in 1786, when he returned to Hackney. He was next choſen afternoon-preacher at the meeting-houſe in Poor Jewry-ſtreet, but this he reſigned on being elected paſtor of the Gravel-pit meeting Hackney, and afternoon-preacher at Newington Green. Theſe he reſigned with a farewel-ſermon in February 1791. Shortly after he was attacked with a nervous fever, which diſappearing was ſucceeded by a diſorder in his bladder, which reduced him to ſuch a degree that, worn out with agony and diſeaſe, he died without a groan on the 19th April 1791. He left his property to a ſiſter and two nephews. Price.

Dr Kippis, ſpeaking of his learning and purſuits, obſerves *, that "his chief aim was to lay a foundation for ſolid knowledge, by an application to ſciences of the nobleſt kind. It was on the great and fundamental principles and obligations of morality, on the higher ſpecies of mathematics, on the ſublimer parts of natural philoſophy, on the true baſis of government, and on the queſtions which relate to the eſſential welfare and dignity of man, that his ſtudies were employed; and in the proſecution of theſe ſtudies he not only enriched his own mind, but was enabled to become of eminent ſervice to his country and to the world. In his moral writings he has laboured with diſtinguiſhed ability to build the ſcience of ethics on an immutable baſis; and what he has advanced will always ſtand high in eſtimation as one of the ſtrongeſt efforts of human reaſon in favour of the ſyſtem he has adopted. For myſelf (adds Dr Kippis), I ſcruple not to ſay, that I regard the treatiſe referred to as a rich treaſure of valuable information, and as deſerving to be ranked among the firſt productions of its kind. With reſpect to his other ethical works, every one muſt admire the zeal, earneſtneſs, and ſtrength, with which he endeavours to lead men into pious views of God, of providence and prayer; and to promote the exerciſe of devout and amiable diſpoſitions. In conſequence of his profound knowledge in mathematical calculations, he was qualified at a particular criſis for being of ſingular utility to his fellow-citizens. A number of ſchemes for inſurance for lives, and the benefit of ſurvivorſhip, promiſing mighty advantages, were riſing up in the metropolis. Theſe ruinous ſchemes would have been carried to great exceſs had not Dr Price ſtepped forward and diſpelled the deluſion. Gratitude will not allow us to forget the ability and ſpirit with which he awakened the attention of his countrymen to the reduction of the national debt. With him it was that the ſcheme of the preſent miniſter for that purpoſe is underſtood to have originated. What crowned the whole of his character was, its being an aſſemblage of the moſt amiable and excellent private virtues. His piety was ſincere, humble, and fervent; his ſoul pure and elevated; in his views diſintereſted and noble; and in his manners mild and gentle: the applauſe of his talents and virtues will be tranſmitted to future ages, and he will be united in the catalogue with the moſt eminent benefactors of mankind."

* *Addreſs at his Funeral*, 8vo.

This is the panegyric of a friend; but with few abatements it will be admitted by every candid reader. In morals Dr Price's principles were thoſe of Cudworth and Clarke; and by many who have themſelves adopted a very different theory, he is allowed to have defended thoſe principles with greater ability than any other writer in the Engliſh language (ſee *MORAL Philoſophy*, n° 14.) In metaphyſics he was perhaps too great an admirer of Plato, from whom he has borrowed a doctrine concerning ideas which we confeſs ourſelves unable to comprehend. He was a firm believer in the immateriality of the ſoul; but, with Dr Law, the late learned biſhop of Carliſle, he thought, that from death to the reſurrection of the body it remains in a dormant or

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Price. quieſcent ſtate. He contended for its indiviſibility, but maintained at the ſame time its extenſion; which furniſhed Dr Prieſtley with ſome advantages in their celebrated controverſy, which his own acuteneſs would never have obtained. In propagating his political principles, which were republican, he ſometimes expreſſed himſelf with undue vehemence; and he was a zealous enemy to all religious eſtabliſhments which, in his opinion, encroach upon that liberty wherewith Chriſt has made us free. His faith reſpecting the Son of God was what has been called ſometimes *low Arianiſm* and ſometimes *Semi-arianiſm*. From a very early age he claimed the privilege of thinking for himſelf on every ſubject. His father was a rigid Calviniſt, and ſpared no pains to inſtil his own theological dogmas into the tender mind of his ſon; but young Richard would often ſtart his doubts and difficulties, and ſometimes incur the old man's diſpleaſure by arguing againſt his favourite ſyſtem with an ingenuity that perplexed, and a ſolidity that could not be eaſily overturned. He had once the misfortune to be caught reading a volume of Clarke's ſermons, which his father in great wrath ſnatched from him and threw into the fire. Perhaps he could not have taken a more effectual method to make the book a favourite, or to excite the young man's curioſity after the other works of the ſame author; and it is by no means improbable that this orthodox bigotry contributed more than any other circumſtance to lay the foundation of his ſon's Arianiſm.

But whatever may be thought of Dr Price's ſpeculative opinions, whether political or religious, his virtues in private life have never been called in queſtion. Of his practical religion it is impoſſible to ſpeak in terms too high. There was a fervour even in his public prayers which indicated the ſtrongeſt ſenſibility as well as ſincerity in himſelf, and communicated its warmth to thoſe who joined with him. But in his family devotions he gave ſtill fuller ſcope to the pious emotions of his ſoul, and proved to thoſe friends who were occaſionally preſent at them how deeply he felt religious impreſſions, and how happily he blended in this as well as in other things the cool deciſions of the underſtanding with the amiable and exalted ſenſibilities of the heart.

But it was not in devotion only that theſe ſenſibilities were diſplayed. He was as exemplary in affection to his relatives as in love to his Maker. Of this he gave a ſtriking though private inſtance before he firſt quitted his native place to try his fortune in London. His father had left to an elder brother by a former marriage a very conſiderable fortune; to Richard he left a mere trifle; and to each of two ſiſters ſtill leſs. Our author divided his ſhare between his ſiſters, reſerving to himſelf only a few pounds to defray the expences of his journey, and truſting for his future ſupport to the bleſſing of God upon his talents and his induſtry. As in early life he was an affectionate and generous brother, in old age he was a loving and attentive huſband. His wife, who for a conſiderable time before her death was almoſt wholly helpleſs, found during the laſt years of her life hardly any enjoyment except in a game at whiſt; and though our Doctor diſliked cards as a waſte of time, and never touched them on any other occaſion, to amuſe her he would ſit down every evening to the card-table, and play till it was late, with a cheerfulneſs and good humour which charmed every perſon who had the happineſs of viewing him in that endearing ſituation. Price.

Yet, though thus attentive to the obligations of domeſtic life, he did not ſuffer his private affections to encroach upon his ſocial duties. His talents and his labours were ever ready at the call of friendſhip; nay, ſo much did his nature abound with the milk of human kindneſs, that he could not reſiſt without extreme reluctance even troubleſome and unreaſonable ſolicitations. His hours of ſtudy and retirement were frequently broken in upon by applications for aſſiſtance and advice, eſpecially in matters relating to annuities and life-inſurances; and in this way he ſacrificed much of his perſonal convenience to individuals of whom he knew but little, and from whom he would accept of no pecuniary recompenſe. His good nature in this reſpect amounted almoſt to a foible; and ſubjected him to importunities and loſs of time, of which he would ſometimes complain as interfering materially with more important and more generally uſeful ſtudies.

Whilſt he thus obliged the rich by his mental talents, he ſuccoured the poor with his earthly ſubſtance. A fifth part of his annual income was regularly devoted to charitable purpoſes; and he was laudably anxious to diſtribute it in ſuch a way as might produce the greateſt good. In the practice of this, and indeed of all his virtues, he was utterly devoid of oſtentation. Simplicity and humility were among the ſtrong features of his character. No man was ever leſs ſenſible of his own excellence, or leſs elated by his own celebrity; and in no man was the dignity of artleſs manners and unaffected modeſty more happily diſplayed.

His face was the true index of his mind. It beamed with philanthropy; and when lighted up in converſation with his friends, aſſumed an aſpect peculiarly pleaſing. His perſon was ſlender, and rather below the common ſize, but poſſeſſed of great muſcular ſtrength and remarkable activity. A habit of deep thought had given a ſtoop to his figure, and he generally walked a briſk pace with his eyes on the ground, his coat buttoned, one hand in his pocket, and the other ſwinging by his ſide.

It is natural to ſuppoſe that ſuch a man as Dr Price, ſome of whoſe writings were tranſlated into foreign languages, would be very generally reſpected in the republic of letters, and have many correſpondents. The ſuppoſition is well founded. In 1763 or 1764 he was choſen a fellow of the Royal Society, and contributed largely to the tranſactions of that learned body; in 1769 he received from Aberdeen a diploma creating him DD.; and in 1783 the degree of LL.D. was conferred upon him by the college of Yale in Connecticut. As in 1770 he had refuſed an American degree which had been conveyed to him by Dr Franklin, his acceptance of one 13 years afterwards can be attributed only to his extravagant attachment to a republican form of government; which was the greateſt defect in his character, and ſhows what prejudices the moſt vigorous mind will imbibe by thinking always on the ſame ſubjects, and in the ſame track. Among his correſpondents, the moſt eminent in his own country were the late Lord Chatham, Lord Stanhope, Lord Lanſdowne, the late biſhops of Carliſle and St Aſaph, and the preſent biſhop of Landaff; Mr Hume, Mr Harris of Saliſbury,

Price. liſbury, Dr Gregory of Edinburgh, and the celebrated Mr Howard, who lived with him on terms of the greateſt intimacy; in America he correſponded with Dr Franklin, Dr Chauncey, Mr Adams, and others; and in France with the celebrated Turgot, the Duke de Rochefoucault, and ſeveral of the firſt national aſſembly. One of his female correſpondents ſketched his character with great juſtneſs many years ago under the fictitious but well applied name of *Simplicius*; and with this character we ſhall cloſe theſe ſhort memoirs.

"While the vain man is painfully ſtriving to outſhine the company and to attract the admiration by falſe wit, forced compliments, and ſtudied graces, he muſt ſurely be mortified to obſerve how conſtantly Simplicius engages their attention, reſpect, and complacency, without having once thought of himſelf as a perſon of any conſequence among them. Simplicius imparts his ſuperior knowledge, when called upon, as eaſily and naturally as he would tell you what it is o'clock; and with the ſame readineſs and good will informs the moſt ignorant or confers with the moſt learned. He is as willing to receive information as to give it, and to join the company, as far as he is able, in the moſt trifling converſation into which they may happen to fall as in the moſt ſerious and ſublime. If he diſputes, it is with as much candour on the moſt important and intereſting as on the moſt inſignificant ſubjects; and he is not leſs patient in hearing than in anſwering his antagoniſt. If you talk to him of himſelf or his works, he accepts praiſe or acknowledges defects with equal meekneſs, and it is impoſſible to ſuſpect him of affectation in either. We are more obliged by the plain unexaggerated expreſſions of his regard, than by the compliments and attentions of the moſt accompliſhed pattern of high breeding; becauſe his benevolence and ſincerity are ſo ſtrongly marked in every look, word, and action, that we are convinced his civilities are offered for our ſakes, not for his own, and are the natural effects of real kindneſs, not the ſtudied ornaments of behaviour. Every one is deſirous to ſhow him kindneſs in return, which we know will be accepted juſt as it is meant. All are ready to pay him that deference which he does not deſire, and to give him credit for more than he aſſumes, or even more than he poſſeſſes. With a perſon ungraceful, and with manners unpoliſhed by the world, his behaviour is always proper, eaſy, and reſpectable; as free from conſtraint and ſervility in the higheſt company, as from haughtineſs and inſolence in the loweſt. His dignity ariſes from his humility; and the ſweetneſs, gentleneſs, and frankneſs of his manners, from the real goodneſs and rectitude of his heart, which lies open to inſpection in all the fearleſſneſs of truth, without any need of diſguiſe or ornament."

Such was Dr Price.—Of his public principles men will think differently; of his private worth there can be but one opinion. He will live in the memory of his friends till memory has loſt her power. To poſterity his works will be his monument. They are: A Review of the principal Queſtions and Difficulties in Morals, 8vo, 1758; Diſſertations on Providence, &c. 8vo, 1767; Obſervations on Reverſionary Payments, &c. 8vo, 1771; Appeal on the National Debt, &c. 8vo, 1773; Obſervations on the Nature of Civil Liberty, 1776; on Materialiſm and Neceſſity, in a correſpondence between Dr Price and Dr Prieſtley, 1779; on Annuities, Aſſurances, Population, &c. 8vo, 1779; on the Population of England, 1780; on the Public Debts, Finances, Loans, &c. 8vo, 1783; on Reverſionary Payments, 2 vols, 1783; on the importance of the American Revolution, 1784: beſides Sermons, and a variety of papers in the Philoſophical Tranſactions on aſtronomical and other philoſophical ſubjects. Pride.

PRIDE, inordinate and unreaſonable ſelf-eſteem, attended with inſolence and rude treatment of others.—It is frequently confounded with vanity, and ſometimes with dignity; but to the former paſſion it has no reſemblance, and in many circumſtances it differs from the latter. Vanity is the parent of loquacious boaſting; and the perſon ſubject to it, if his pretences be admitted, has no inclination to inſult the company. The proud man, on the other hand, is naturally ſilent, and, wrapt up in his own importance, he ſeldom ſpeaks but to make his audience feel their inferiority. It is this circumſtance which diſtinguiſhes pride from dignity, and conſtitutes its ſinfulneſs. Every man poſſeſſed of great powers of mind is conſcious of them, and feels that he holds a higher rank in the ſcale of exiſtence than he whoſe powers are leſs. If he recollect, at the ſame time, that he has nothing which he did not receive, and that his ſuperiority is owing to the good pleaſure of Him who forms his creatures differently, as the potter forms his clay; he will be ſo far from inſulting his inferiors, that when neceſſarily in company with them, he will bear with their foibles, and, as far as is proper, make them loſe ſight of the diſtance which the laws of God and man have for ever placed between them and him. This condeſcenſion, however, if he be a man of dignity, will never lead him to join with them in any mean or dirty action. He will even excuſe in them many things which he would condemn in himſelf, and give them his good wiſhes, after they have forfeited his eſteem. Such a character is amiable and reſpectable, and what every man ſhould labour to obtain. From the weakneſs of human nature, however, it is too apt to degenerate into pride.

To a man of great intellectual powers and various erudition, the converſation of ordinary perſons affords neither inſtruction nor amuſement; and ſuch converſation, when often repeated, muſt, from the nature of things, become tedious and irkſome. But it requires great command of temper and of manners to prevent uneaſineſs long felt from ſometimes betraying itſelf by external ſymptoms, ſuch as peeviſh expreſſions, a forbidding look, or abſence of mind; and theſe are the infallible indications of contempt for the company, the very worſt ingredient in the paſſion of pride. If this contempt be often excited, it will be formed into a habit; and the proud man will be ſo much under its influence, as to inſult his inferiors, and ſometimes his equals, without forming the reſolution to inſult either the one or the other. Such a character is hateful to every company, and is ſo far from indicating true dignity of mind in him to whom it belongs, that it is obviouſly aſſociated with meanneſs, and indicates a conſciouſneſs of ſome radical defect. He who poſſeſſes real and conſpicuous merit has no occaſion to depreſs others for the purpoſe of raiſing himſelf; his ſuperiority will be cheerfully acknowledged: but when a man of undoubted

Pride || Priene.

eminence in one reſpect, is ſo ſwollen with pride as to make him wiſh to appear great in all reſpects, he has no other means of enforcing his ill-founded claim, than diſplaying his acknowledged ſuperiority, with ſuch inſolence as may drive at a diſtance from him every perſon by whom he is conſcious that in many inſtances he might be more than rivalled. Whoever is proud of knowledge, would do well to conſider how much knowledge he wants.

The ſame obſervations which we have made on pride of parts will apply to every other ſpecies of pride, ſuch as pride of birth, office, or riches, &c. The peace and order of ſociety require difference of rank, accompanied with different degrees of authority; and he who inherits a title or office from his anceſtors, may without pride be conſcious of his ſuperiority, provided he forget not that ſuch ſuperiority is conferred on families and individuals, not for their own ſakes, but for the good of the community. The peer, who keeps this circumſtance in mind, may maintain his ſtation, and repreſs the forward petulance of the plebeian, without giving offence to any thinking man; but if he dwell upon his rank with too much complacency, he will in proceſs of time be apt to conſider himſelf and his family as ſuperior by nature to thoſe upon whom no title has been conferred, and then his pride will become intolerable. If we could trace our deſcents, ſays Seneca, we ſhould find all ſlaves to come from princes, and all princes from ſlaves. To be proud of knowledge, is to be blind in the light; to be proud of virtue, is to poiſon ourſelves with the antidote; to be proud of authority, is to make our riſe our downfal. The beſt way to humble a proud man is to neglect him.

PRIDEAUX (Humphry) was born at Padſtow in Cornwall in 1648, and was honourably deſcended by both parents. Three years he ſtudied at Weſtminſter under Dr Buſby; and then was removed to Chriſt-church, Oxford. Here he publiſhed, in 1676, his *Marmora Oxonienſia ex Arundelianis, Seldenianis, aliiſque conflata, cum perpetuo Commentario.* This introduced him to the lord chancellor Finch, afterward earl of Nottingham, who in 1679 preſented him to the rectory of St Clements near Oxford, and in 1681 beſtowed on him a prebend of Norwich. Some years after he was engaged in a controverſy with the Papiſts at Norwich, concerning the validity of the orders of the church of England, which produced his book upon that ſubject. In 1688 he was inſtalled in the archdeaconry of Suffolk; to which he was collated by Dr Lloyd, then biſhop of Norwich. In 1691, upon the death of Dr Edward Pococke, the Hebrew profeſſorſhip at Oxford being vacant, was offered to Dr Prideaux, but he refuſed it. In 1697, he publiſhed his Life of Mahomet, and in 1702 was inſtalled dean of Norwich. In 1710 he was cut for the ſtone, which interrupted his ſtudies for more than a year. Some time after his return to London, he proceeded with his Connection of the Hiſtory of the Old and New Teſtament; which he had begun when he laid aſide the deſign of writing the Hiſtory of Appropriations. He died in 1724.

Chandler's Travels in Aſia Minor.

PRIENE, an ancient town of Aſia Minor. It is now called *Samſun*, and *Samſun-kateſi*, which do not however appear to be very recent. It was taken in 1391 by Bajazet, who ſubdued Ionia. It had formerly, without including the citadel, three gateways; one of which was towards Kelibeſh, an adjoining village; and without it are vaults of ſepulchres. The entrance was not wide. A part of the arch, conſiſting of a ſingle row of maſſive ſtones, ſtill remains; but thoſe on which it reſts are ſo corroded by age, broken, or diſtorted, as to ſeem every moment ready to yield and let down their load. A rugged way leads to a ſecond opening in the wall oppoſite to this, and about a mile from it; beyond which are likewiſe vaults of ſepulchres. Between theſe was a gate facing to the plain; and on the left hand going out of it is a hole, reſembling the mouth of an oven, in the ſide of a ſquare tower; and over it an inſcription in ſmall characters, exceedingly difficult to be read. It ſignifies, that a certain Cyprian in his ſleep had beheld Ceres and Proſerpine arrayed in white; and that in three viſions they had enjoined the worſhip of a hero, the guardian of the city, and pointed out the place where, in obedience to them, he had erected the god. This was probably ſome local hero, whoſe little image was ſet in the wall, and whoſe name and memory have periſhed.

Prieſt.

PRIEST, a perſon ſet apart for the peformance of ſacrifice, and other offices and ceremonies of religion. Before the promulgation of the law of Moſes, the firſt-born of every family, the fathers, the princes, and the kings, were prieſts. Thus Cain and Abel, Noah, Abraham, Melchizedec, Job, Iſaac, and Jacob, offered themſelves their own ſacrifices. Among the Iſraelites, after their exod from Egypt, the prieſthood was confined to one tribe, and it conſiſted of three orders, the *high*-prieſt, *prieſts*, and *Levites*. The prieſthood was made hereditary in the family of Aaron, and the firſt-born of the oldeſt branch of that family, if he had no legal blemiſh, was always the high-prieſt. This divine appointment was obſerved with conſiderable accuracy till the Jews fell under the dominion of the Romans, and had their faith corrupted by a falſe philoſophy.—Then, indeed, the high-prieſthood was ſometimes ſet up to ſale, and inſtead of continuing for life, as it ought to have done, it ſeems, from ſome paſſages in the New Teſtament, to have been nothing more than an annual office. There is ſufficient reaſon, however, to believe, that it was never diſpoſed of but to ſome deſcendant of Aaron, capable of filling it, had the older branches been extinct. (For the conſecration and offices of the Jewiſh prieſthood, we refer our readers to the books of Moſes). In the time of David, the inferior prieſts were divided into 24 companies, who were to ſerve in rotation, each company by itſelf, for a week. The order in which the ſeveral courſes were to ſerve was determined by lot; and each courſe was in all ſucceeding ages called by the name of its original chief.—All nations have had their *prieſts*. The Pagans had *prieſts* of Jupiter, Mars, Bacchus, Hercules, Oſiris, and Iſis, &c.; and ſome deities had *prieſteſſes*. The Mahometans have prieſts of different orders, called *ſchiek*, and *mufti*; and the Indians and Chineſe have their *bramins* and *bonzes*.

It has been much diſputed, whether, in the Chriſtian church, there be any ſuch officer as a *prieſt*, in the proper ſenſe of the word. The church of Rome, which holds the *propitiatory* ſacrifice of the *maſs*, has of courſe her proper *prieſthood*. In the church of England, the word *prieſt* is retained to denote the ſecond order in her hierarchy, but we believe with very different ſignifications, according to the different opinions entertained of the Lord's

Primæ ‖ Primer.

Lord's ſupper. Some few of her divines, of great learning, and of undoubted Proteſtantiſm, maintain that the Lord's ſupper is a *commemorative* and *euchariſtical ſacrifice*. Theſe conſider all who are authoriſed to adminiſter that ſacrament as in the ſtricteſt ſenſe *prieſts*. Others hold the Lord's ſupper to be a *feaſt* upon the *one* ſacrifice, once offered on the croſs; and theſe too muſt conſider themſelves as clothed with ſome kind of prieſthood. Great numbers, however, of the Engliſh clergy, perhaps the majority, agree with the church of Scotland, in maintaining that the Lord's ſupper is a rite of no other moral import, than the mere commemoration of the death of Chriſt. Theſe cannot conſider themſelves as *prieſts* in the rigid ſenſe of the word, but only as *preſbyters*, of which the word *prieſt* is a contraction of the ſame import with *elder*. See *Supper of the Lord*.

PRIMÆ VIÆ, among phyſicians, denote the whole alimentary duct; including the œſophagus, ſtomach, and inteſtines, with their appendages.

PRIMAGE, in commerce, a ſmall duty at the water-ſide, uſually about 12d. *per* ton, or 6d. *per* bale, due to the maſter and mariners of a ſhip.

PRIMARY, firſt in dignity, chief, or principal.

Primary Qualities of Bodies. See Metaphysics, n° 152.

PRIMATE, in church-polity, an archbiſhop, who is inveſted with a juriſdiction over other biſhops.

PRIME, PRIMUS, an appellation given to whatever is firſt in order, degree, or dignity, among ſeveral things of the ſame or like kind; thus we ſay, the prime miniſter, prime coſt, &c.

Prime is ſometimes uſed to denote the ſame with decimal, or the tenth part of an unit.

Prime-Figure, in geometry, one which cannot be divided into any other figures more ſimple than itſelf, as a triangle among planes, and the pyramid among ſolids.

For prime numbers, in arithmetic, ſee the article Number.

Prime of the Moon, is the new moon when ſhe firſt appears, which is about three days after the change.

Prime Vertical, is that vertical circle which paſſes through the poles of the meridian, or the eaſt and weſt points of the horizon; whence dials projected on the plane of this circle are called *prime vertical*, or *north-and-ſouth dials*.

Prime, in the Romiſh church, is the firſt of the canonical hours, ſucceeding to lauds.

Prime, in fencing, is the firſt of the chief guards. See Guard.

PRIMER SEASIN, in feodal law, was a feodal burden, only incident to the king's tenants *in capite*, and not to thoſe who held of inferior or meſne lords. It was a right which the king had, when any of his tenants *in capite* died ſeized of a knight's fee, to receive of the heir (provided he were of full age) one whole year's profits of the lands if they were in immediate poſſeſſion, and half a year's profits if the lands were in reverſion expectant on an eſtate for life. This ſeems to be little more than an additional relief, (ſee Relief); but grounded upon this feodal reaſon, That, by the ancient law of feods, immediately upon the death of a vaſſal the ſuperior was entitled to enter and take ſeiſin or poſſeſſion of the land, by way of protection againſt intruders, till the heir appeared to claim it, and receive inveſtiture: and for the time the lord ſo held it, he was entitled to take the profits; and unleſs the heir claimed within a year and day, it was by the ſtrict law a forfeiture. This practice however ſeems not to have long obtained in England, if ever, with regard to tenures under inferior lords; but, as to the king's tenures *in capite*, this *prima ſeiſina* was expreſsly declared, under Hen. III. and Ed. II. to belong to the king by prerogative, in contradiſtinction to other lords. And the king was entitled to enter and receive the whole profits of the land, till livery was ſued; which ſuit being commonly within a year and day next after the death of the tenant, therefore the king uſed to take at an average the *firſt-fruits*, that is to ſay, one year's profits of the land. And this afterwards gave a handle to the popes, who claimed to be feodal lords of the church, to claim in like manner from every clergyman in England the firſt year's profits of his benefice, by way of *primitiæ*, or firſt-fruits.—All the charges ariſing by primer ſeiſin were taken away by 12 Car. II. c. 24.

Priming ‖ Primogeniture.

PRIMING, in gunnery, the train of powder that is laid, from the opening of the vent, along the gutter or channel on the upper part of the breech of the gun: which, when fired, conveys the flame to the vent, by which it is further communicated to the charge, in order to fire the piece. This operation is only uſed on ſhipboard at the proof, and ſometimes in garriſon; for, on all other occaſions, tubes are uſed for that purpoſe.

Priming-Wire, in gunnery, a ſort of iron needle employed to penetrate the vent or touch-hole of a piece of ordnance, when it is loaded: in order to diſcover whether the powder contained therein is thoroughly dry and fit for immediate ſervice; as likewiſe to ſearch the vent and penetrate the cartridge, when the guns are not loaded with the looſe powder.

Priming, among painters, ſignifies the laying on of the firſt colour.

PRIMIPILUS, in antiquity, the centurion of the firſt cohort of a legion, who had the charge of the Roman eagle.

PRIMITIÆ, the firſt-fruits gathered of the earth, whereof the ancients made preſents to the gods.

PRIMITIVE, in grammar, is a root or original word in a language, in contradiſtinction to *derivative*; thus, *God* is a primitive; *godly*, a derivative; and *god-like*, a compound.

PRIMOGENITURE, the right of the firſt-born, has among moſt nations been very conſiderable. The firſt-born ſon in the patriarchal ages had a ſuperiority over his brethren, and, in the abſence of his father, was prieſt to the family. Among the Jews, he was conſecrated to the Lord, had a double portion of the inheritance, and ſucceeded in the government of the family or kingdom. It is, however, remarkable, and unqueſtionably ſhows the connection between this inſtitution and the birth and office of our Saviour, that if a woman's firſt child was a girl, neither ſhe, nor the children that came after her, were conſecrated.

In every nation of Europe, the right of primogeniture prevails in ſome degree at preſent, but it did not

Primorie, Primula.

prevail always. The law which calls the elder-born to the crown, preferably to the others, was not introduced into France till very late; it was unknown to the firſt race of kings, and even to the ſecond. The four ſons of Clovis ſhared the kingdom equally among themſelves; and Louis le Debonnaire did the ſame: it was not till the race of Hugh Capet, that the prerogative of ſucceſſion to the crown was appropriated to the firſt-born.

By the ancient cuſtom of *Gavel-kind*, ſtill preſerved in ſome parts of our iſland, primogeniture is of no account; the paternal eſtate being equally ſhared by all the ſons. And it has been a matter of violent and learned diſpute, whether, at the death of Alexander III. Baliol or Bruce was, by the law as it then ſtood, heir to the crown of Scotland. The former had undoubtedly the right of primogeniture, but the latter ſtood in one degree of nearer relation to the deceaſed ſovereign; and the Scottiſh barons, not being able to determine whoſe claim was beſt founded, referred the queſtion to Edward I. of England, and thereby involved their country in a long and ruinous war. See SCOTLAND.

PRIMORIE, is a name given by the Slavi to that tract of ſea-coaſt which lies between the two rivers Cettina and Narenta, the firſt of which is the Neſtus and Tiluras, and the ſecond the Narus, of the ancients; compriſing what was properly called Dalmatia two ages before our era, and which was known to the Greeks of the low times under the name of *Paratalaſſia*. Appian informs us, that the Ardei or Vardei poſſeſſed many cities there, part of which they ſeized before the invaſion of the Romans, and part they built themſelves. We learn alſo from the *Tabula Pentingeriana*, that after the conqueſt many of thoſe cities remained, and were inhabited by the conquerors, who alſo founded new ſettlements. And indeed were theſe proofs wanting, the numerous inſcriptions found near the ſea, and ſometimes among the hills, would render it at leaſt probable. The coaſt is extremely pleaſant, the ſoil fertile, and the ſituation moſt convenient for commerce with the inland provinces. By bad management, however, much ground has been loſt near the ſea, by its being covered with gravel, and by imprudent cultivation of the hills, the impetuous fury of the mountain torrents has rendered a part of it uninhabitable. Macarſka is now the only town in the territory, and it appears to have riſen out of the ruins of the ancient RATANEUM of Pliny. It formed a part of the Narentan ſtate for ſeveral ages, and afterwards, together with the reſt of Primorie, paſſed under the obedience of various Chriſtian princes. It afterwards became ſubject to the Ottoman Porte, and at laſt voluntarily ſubjected itſelf to the Venetian republic. See DALMATIA and MACARSKA. See alſo Fortis's *Travels into Dalmatia*, p. 265——318.

PRIMULA, the PRIMROSE: A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 21ſt order, *Precie*. The involucrum lies under a ſimple umbel; the tube of the corolla cylindrical; with the mouth or limb patulous. This genus, including alſo the polyanthus and auricula, furniſhes an excellent collection of low, fibrous-rooted, herbaceous flowery perennials.

1. The primula veris, or ſpring primroſe, has thick and very fibrous roots, crowned by a cluſter of large oblong indented rough leaves, and numerous flower-ſtalks, from about three or four, to five or ſix inches high; each terminated commonly by one flower.—The varieties are, common yellow-flowered primroſe of the woods—white primroſe—paper-white—red—double red—double yellow, and double white.—All theſe flower abundantly in March and April, and continue for a month or ſix weeks. Primula.

The cowſlip primroſe, or cowſlip, has very thick fibrous roots, crowned by a cluſter of oblong, indented round leaves, and upright, firm, flower-ſtalks five or ſix inches high, terminated each by a cluſter of ſmall flowers. The varieties are, Common ſingle yellow cowſlip of the meadows—double yellow cowſlip—ſcarlet cowſlip—hoſe-and-hoſe cowſlip; one flower growing out of the boſom of another, the lowermoſt ſerving as a calyx; all of which varieties have the flower-ſtalks crowned by many flowers in branches.—They flower in April and May, continuing in ſucceſſion a month or ſix weeks.

2. The polyanthus, has thick fibrous roots, increaſing into large bunches, crowned with a cluſter of large oblong indented rough leaves; amidſt them upright flower-ſtalks ſix or eight inches high, terminated moſtly by a cluſter of ſeveral ſpreading flowers of many different colours in the varieties. The principal are, purple, red, gold, orange-coloured, &c. They all flower beautifully in April and May, and frequently again in autumn; and ſometimes even in winter, if the ſeaſon is mild. The polyanthus is one of the noted prize-flowers among the floriſts; many of whom are remarkably induſtrious in raiſing a conſiderable variety of different ſorts, as well as in uſing every art to blow them with all requiſite perfection; for, among the virtuoſi, a polyanthus muſt poſſeſs ſeveral peculiar properties in order to be admitted in their collections. The chief properties required in a floriſt's polyanthus are, 1. The ſtem or flower-ſtalk ſhall be upright, moderately tall, with ſtrength in proportion, and crowned by a good regular bunch of flowers on ſhort pedicles, ſtrong enough to ſupport them nearly in an upright poſition. 2. The florets of each branch ſhould be equally large, ſpreading open flat, with the colours exquiſite, and the ſtripes and variegations lively and regular. 3. The eye in the centre of each floret ſhould be large, regular, and bright; and the antheræ, by the floriſts called the *thrum*, ſhould riſe high enough to cover the mouth of the tube or hollow part in the middle of the florets, and render them what they call *thrum-eyed*; but when the ſtyle elevates the ſtigma above the antheræ, the eye of the tube generally appears hollow, ſhowing the ſtigma in the middle, like the head of a pin, and is rejected as an incomplete flower, though its other properties ſhould be ever ſo perfect. This pin-eyed polyanthus, however, though rejected by the floriſts, is the flower in its moſt perfect ſtate, and great numbers of them are of as beautiful forms and colours as the thrum-eyed varieties.

3. The auricula has a thick fibrous root, crowned by a cluſter of oblong, fleſhy, broad, ſerrated, ſmooth leaves, reſembling the ſhape of a bear's ear; and amidſt them upright flower-ſtalks from about three or four to ſix or eight inches high, terminated by an umbellate cluſter of beautiful flowers, of many different colours

Primum, Prince.

colours in the varieties. All of theſe have a circular eye in the middle of each flower, and of which there are different colours; whence the auriculas are diſtinguiſhed into yellow-eyed, white-eyed, &c. The petals of moſt of the kinds are powdered with an exceeding fine farina or mealy powder, which contributes greatly to the beauty of the flower. They all flower in April or May, continuing a month or ſix weeks in beauty, and ripening plenty of ſeeds in June.

Culture. All the varieties of the common ſpring primroſe multiply ſo faſt by the roots, that it is ſcarce worth while to raiſe them from ſeeds. However, though many ſingle kinds may be raiſed from ſeed, yet parting the roots is the only method by which the double kind can be preſerved; and the ſame thing is to be obſerved of all the reſt.

PRIMUM MOBILE, in the Ptolemaic aſtronomy, the ninth or higheſt ſphere of the heavens, whoſe centre is that of the world, and in compariſon of which the earth is but a point. This they will have to contain all other ſpheres within it, and to give motion to them, turning itſelf, and all them, quite round in 24 hours.

PRINCE, PRINCEPS, in polity, a perſon inveſted with the ſupreme command of a ſtate, independent of any ſuperior.

PRINCE alſo denotes a perſon who is a ſovereign in his own territories, yet holds of ſome other as his ſuperior; ſuch are the princes of Germany, who, though abſolute in their reſpective principalities, are bound to the emperor in certain ſervices.

PRINCE alſo denotes the iſſue of princes, or thoſe of the royal family. In France, before the revolution, they were called *princes of the blood*, and during the ſhort continuance of the conſtitution of 1791, *French princes*. In England the king's children are called *ſons and daughters of England*; the eldeſt ſon is created prince of Wales; the cadets are created dukes or earls as the king pleaſes; and the title of all the children is *royal highneſs*: all ſubjects are to kneel when admitted to kiſs their hand, and at table out of the king's preſence they are ſerved on the knee. See *ROYAL Family*.

PRINCE of the Senate, in old Rome, the perſon who was called over firſt in the roll of ſenators, whenever it was renewed by the cenſors: he was always of conſular and cenſorian dignity. See the article SENATE.

PRINCE's Metal, a mixture of copper and zinc, in imitation of gold. See CHEMISTRY, n° 1154.

PRINCETOWN. See *New JERSEY*.

Edin. Phil. Tranſ. v. iii. p. 13. &c.

PRINCE of Wales's Iſland, or *Pulo Penany*, is ſituated in the entrance of the ſtraits of Malacca, in 100 degrees of eaſt longitude, and in five degrees of north latitude. It is about ſeven leagues in length and three in breadth. Its northern extremity runs nearly parallel with the main land at a diſtance of about two miles, by which a fine channel is formed, where the greateſt fleets might ride in perfect ſafety, the height of the ſurrounding mountains acting as a barrier againſt the force of the prevailing winds. The climate, conſidering its vicinity to the equator, is remarkably mild. Eighty degrees is about the mean height of the thermometer at noon, which, during the night, is ſeldom above 70. Its healthfulneſs is certainly not ſurpaſſed by that of any European ſettlement on the coaſt. Out of a garriſon of 300 troops (natives of Hindoſtan), not one died for the ſpace of 14 months; a ſingular fact to be experienced by a new ſettlement in an uncleared country. This great ſalubrity is perhaps the effect of a conſtant ventilation, ſupported by almoſt continued but gentle breezes, added to the dryneſs of the ſoil, the uniform but gradual elevation from the ſea to the foot of the hills preventing thoſe ſtagnations of water which, in tropical latitudes, are ſo highly prejudicial to the health of man. Prince.

A ridge of beautiful mountains, deeply indented with valleys, and covered with evergreens, divides the iſland longitudinally. Innumerable rivulets receive their origin from theſe mountains, and are remarkable for the tranſparency and coolneſs of their waters. The ſoil, which is light and ſandy near the ſea, gradually changes to a rich clay as it approaches to the high lands. There the ſugar-cane grows with the utmoſt luxuriance, and the moſt plentiful crops of rice are everywhere produced. The gardens have already furniſhed the inhabitants with cabbages and potatoes; and when induſtry ſhall have reached the tops of the mountains, it will be no ſurpriſe to ſee in the plantations moſt of the productions of Europe in their utmoſt perfection. In decorating the landſcapes of this little iſland, nature has been peculiarly laviſh. An aſſemblage of flowering trees and ſhrubs in perpetual bloſſom, and endleſs in the variety of their ſpecies, form the firſt ſhade. Theſe are overtopped by foreſt trees of an immenſe height, which ſpread their vaſt branches on every ſide, and are covered with the richeſt foliage. Here ſtrangers feel with rapture the effect of the breezes, which, from whatſoever quarter they blow, are ſtrongly impregnated with the fragrance of the groves.

The original animal productions of this iſland are very limited. Of quadrupeds, the wild hog, deer, and ſquirrel, nearly comprehend the whole; but the abſence of the tiger and leopard, whoſe numbers and ferocity almoſt render the oppoſite ſhores uninhabitable, amply compenſates for this deficiency. The flying fox and ſquirrel are natives of this iſland; the former a nondeſcript, and a great natural curioſity. Of birds there are alſo but few, and only one which is remarkable for the melody of its notes. The crow and ſparrow, the never-failing attendants on population, have but lately made their appearance. They are now, however, rapidly increaſing and multiplying. All the domeſtic animals arrive here at great perfection.

The ſea which ſurrounds the iſland, affords a vaſt variety of fiſh of the moſt delicious flavour, and its ſhores abundance of the fineſt turtle and oyſters. In no ſituation indeed are the conveniencies and luxuries of life enjoyed in greater profuſion. The advantages of the iſland in a political and commercial view, are too obvious to require to be pointed out.

PRINCE William's Sound, ſituated on the north-weſt coaſt of America, and ſo named by Captain Cook in 1778. The men, women, and children of this ſound are all clothed in the ſame manner. Their ordinary dreſs is a ſort of cloſe frock, or rather robe, which ſometimes reaches only to the knees, but generally down to the ancles. Theſe frocks are compoſed of the ſkins of various animals, and are commonly worn with the hairy ſide outwards. The men often paint their faces of a black colour, and of a bright red, and ſometimes of a bluiſh or leaden hue; but not in any regu-

Prince, Principal.

lar figure. The women puncture or ſtain the chin with black, that comes to a point in each of their cheeks. Their canoes are of two ſorts; the one large and open, the other ſmall and covered. The framing conſiſts of ſlender pieces of wood, and the outſide is compoſed of the ſkins of ſeals, or other ſea animals, ſtretched over the wood. Their weapons, and implements for hunting and fiſhing, are the ſame as thoſe uſed by the Greenlanders and Eſquimaux. Many of their ſpears are headed with iron, and their arrows are generally pointed with bone. The food they were ſeen to eat was the fleſh of ſome animal, either roaſted or broiled, and dried fiſh. Some of the former that was purchaſed had the appearance of bear's fleſh. They alſo eat a larger ſort of fern-root, either baked or dreſſed in ſome other method. Their drink, in all probability, is water; for, in their canoes, they brought ſnow in wooden veſſels, which they ſwallowed by mouthfuls. Our knowledge of the animals of this part of the American continent is entirely derived from the ſkins that were brought by the natives for ſale. Theſe were principally of bears, common and pine martins, ſea-otters, ſeals, racoons, ſmall ermines, foxes, and the whitiſh cat or lynx. The birds found here were the halcyon, or great king's-fiſher, which had fine bright colours; the white-headed eagle, and the humming-bird. The fiſh that were principally brought to market for ſale were torſk and halibut. The rocks were almoſt deſtitute of ſhell-fiſh; and the only other animal of this tribe that was obſerved was a reddiſh crab, covered with very large ſpines. Few vegetables of any kind were obſerved; and the trees that chiefly grew about this ſound were the Canadian ſpruce pine, ſome of which were of a conſiderable ſize. E. Long. 115. 21. N. Lat. 59. 33.

PRINCIPAL, the chief and moſt neceſſary part of a thing. The principal of a college or hall is the maſter thereof.

In commerce, principal is the capital of a ſum due or lent; ſo called in oppoſition to intereſt. See INTEREST.

It alſo denotes the firſt fund put by partners into a common ſtock, by which it is diſtinguiſhed from the calls or acceſſions afterwards required.

PRINCIPAL, in muſic. See FUNDAMENTAL, in muſic, and GENERATOR, in muſic.

PRINCIPAL, in law, is either the actor or abſolute perpetrator of the crime, who is called a *principal*, in the firſt degree; or he who is preſent, aiding and abetting the fact to be done, who is denominated a *principal* in the ſecond degree. The preſence of a principal need not always be an actual immediate ſtanding by, within ſight or hearing of the fact; but there may be alſo a conſtructive preſence, as when one commits a robbery or murder, and another keeps watch or guard at ſome convenient diſtance. And this rule has alſo other exceptions; for, in caſe of murder by poiſoning, a man may be a principal felon by preparing and laying the poiſon, or giving it to another (who is ignorant of its poiſonous quality) for that purpoſe; and yet not adminiſter it himſelf, nor be preſent when the very deed of poiſoning is committed. And the ſame reaſoning will hold, with regard to other murders committed in the abſence of the murderer, by means which he had prepared before-hand, and which probably could not fail of their miſchievous effect. As by laying a trap or pit-fall for another, whereby he is killed; letting out a wild beaſt, with an intent to do miſchief; or exciting a madman to commit murder, ſo that death thereupon enſues: in every one of theſe caſes the party offending is guilty of murder as a principal, in the firſt degree. For he cannot be called an acceſſory, that neceſſarily pre-ſuppoſing a principal; and the poiſon, the pit-fall, the beaſt, or the madman, cannot be held principals, being only the inſtruments of death. As therefore he muſt be certainly guilty, either as principal or acceſſory, and cannot be ſo as acceſſory, it follows that he muſt be guilty as principal; and if principal, then in the firſt degree; for there is no other criminal, much leſs a ſuperior in the guilt, whom he could aid, abet, or aſſiſt.

Blackſt. Comment. b. iv. c. 3.

Principal || Principle.

PRINCIPAL Point, in perſpective, is a point in the perſpective plane, upon which a line is drawn from the eye, perpendicular to the plane falls.

This point is in the interſection of the horizontal and vertical plane; and is alſo called the *point of ſight*, and *point of the eye*. See PERSPECTIVE.

PRINCIPAL Ray, in perſpective, is that which paſſes perpendicularly from the ſpectator's eye to the perſpective plane, or picture.

Whence the point where this ray falls on the plane, is by ſome alſo called the *principal point*, which other writers call *the centre of the picture*, and *the point of concurrence*.

PRINCIPATO, the name of a province of Italy, in the kingdom of Naples, which is divided into two parts, called by the Italians the *Principato Ultra* and the *Principato Citra*, that is, the Hither and Farther Principato. The Hither Principato is bounded on the north by the Farther Principato and part of the Terra-di-Lavoro, on the weſt and ſouth by the Tuſcan Sea, and on the eaſt by the Baſilicata. It is about 60 miles in length, and 30 in breadth; the ſoil is fertile in wine, corn, oil, and ſaffron; and they have a great deal of ſilk, beſides ſeveral mineral ſprings. The capital town is Salerno. The Farther Principato is bounded on the north by the county of Moleſe and the Terra-di-Lavoro, on the weſt by the Tuſcan Sea, on the ſouth by the Hither Principato, and on the eaſt by the Capitanata. It is about 37 miles in length, and 30 in breadth. The Apennine mountains render the air cold; and the ſoil is not very fertile either in corn or wine, but it produces cheſnuts, and paſtures in great plenty. Benevento is the capital town.

PRINCIPLE, PRINCIPIUM, in general, is uſed for the cauſe, ſource, or origin of any thing.

PRINCIPLE, in human nature. See DISPOSITION.

PRINCIPLE, in ſcience, is a truth, admitted without proof, from which other truths are inferred by a chain of reaſoning. Principles are of two kinds, *primary* and *general*; and to the laſt the name of *axioms* is uſually given on account of their importance and *dignity*. An axiom or *general* principle, when the terms in which it is expreſſed are underſtood, muſt be a ſelf-evident truth; but from its very nature it cannot be a *firſt* truth. Our firſt truths are all *particular*. A child knows that two *particular* lines, each an inch long, are equal to one another, before he has formed any *general* notions of length and equality. "Things equal to one and the ſame thing are equal to one another," is the

Principle Pringle.

first of Euclid's axioms; and an axiom it undoubtedly is, but to no man has it been a *firſt* truth. It is, if we may uſe the expreſſion, a *genus* or *claſs* of truths comprehending under it numberleſs individuals. Were a full-grown man introduced into the world, without a ſingle idea in his mind, as we may ſuppoſe Adam to have been, he would inſtantly perceive, upon laying together three pieces of wood each a foot long, that they were all equal in length; and if he were to cut another to the ſame length with *any one* of them, he would find upon trial, that it was of the ſame length with them all. After a few ſimple experiments of this kind, he would, by a law of human thought, infer that all things equal in length or in any other dimenſion, to any *one* thing, are in that dimenſion equal to one another.

It was not therefore with ſuch weakneſs as ſome have imagined, that Hobbes affirmed thoſe propoſitions commonly called axioms, not to be primary but ſecondary principles. A primary principle deſerves not the name of an axiom, as it is only a particular truth including in it no other truth. There is not one of Euclid's axioms which has not been the reſult of induction, though we remember not the time at which the induction was made. That the whole is greater than any of its parts is a general truth which no man of common ſenſe can controvert; but every one diſcovered that truth by obſerving that his body was larger than his head, his foot, or his hand; that a mountain is larger than a mole-hill in the middle of it; and that a piece of timber meaſuring what is called a yard is longer than any one of the diviſions marked upon it, and termed inches. The particular obſervations are made through the ſenſes and treaſured up in the memory; and the intellect, by its conſtitution, compares them together, marks in what they agree and diſagree, and thence draws its *axioms* or *general* principles. He, therefore, who ſhould admit the truth of an axiom, and deny the evidence of ſenſe and perception, would act as abſurdly as he who accepts payment in a bank-bill, and refuſes it in the individual pieces of gold or ſilver which that bill repreſents. General axioms are of infinite uſe in the purſuits of ſcience; but it is not becauſe they create new truths; they only ſhorten the proceſs in the diſcovery of ſuch as might be found, with labour, through the medium of particular propoſitions. See *Campbell's Philoſophy of Rhetoric* and *Tatham's Chart and Scale of Truth*.

Principles, in phyſics, are often confounded with elements, or the firſt and ſimpleſt parts whereof natural bodies are compounded, and into which they are again reſolvable by the force of fire.

PRINGLE (Sir John), an eminent phyſician and philoſopher, was a younger ſon of Sir John Pringle of Stitchel, in the ſhire of Roxburgh, Baronet; took the degree of M. D. at Leyden, 1730; and publiſhed there *Diſſertatio Inauguralis de Marcore Senili*, 4to. After having been ſome years profeſſor of moral philoſophy at Edinburgh, he was in June 1745 appointed phyſician to the duke of Cumberland, and phyſician-general to the hoſpital of the forces in Flanders, where the earl of Stair appears to have been his patron. In February 1746, Dr Pringle, Dr Armſtrong, and Dr Barker, were nominated phyſicians to the hoſpital for lame, maimed, and ſick ſoldiers, behind Buckingham-houſe; and in April 1749, Dr Pringle was appointed phyſician in ordinary to the king. In 1750 he publiſhed "Obſervations on the Nature and Cure of Hoſpital and Gaol Fevers, in a Letter to Dr Mead," 8vo (reprinted in 1755); and in 1752 he favoured the public with the reſult of his long experience in an admirable treatiſe under the title of "Obſervations on the Diſorders of the Army in Camp and Garriſon," 8vo. On the 14th of April 1752, he married Charlotte, ſecond daughter of Dr Oliver, an eminent phyſician at Bath. In 1756 he was appointed jointly with Dr Wintringham (now Sir Clifton Wintringham, Bart.) phyſician to the hoſpital for the ſervice of the forces of Great Britain. After the acceſſion of his preſent majeſty, Dr Pringle was appointed phyſician to the queen's houſehold, 1761; phyſician in ordinary to the queen in 1763, in which year he was admitted of the college of phyſicians in London; and on the 5th of June 1766, he was advanced to the dignity of a baronet of Great Britain. In 1772 he was elected preſident of the Royal Society, where his ſpeeches for five ſucceſſive years, on delivering the prize-medal of Sir Godfrey Copley, gave the greateſt ſatisfaction. Sir John Pringle in 1777 was appointed phyſician-extraordinary to the king. He was alſo a fellow of the College of Phyſicians at Edinburgh, and of the Royal Medical Society at Paris; member of the Royal Academies at Paris, Stockholm, Gottingen, and of the Philoſophical Societies at Edinburgh and Haerlem; and continued preſident of the Royal Society till November 1778; after which period he gradually withdrew from the world, and in 1781 quitted his elegant houſe in Pall Mall (where he had long diſtinguiſhed himſelf as the warm friend and patron of literary men of every nation and profeſſion), and made an excurſion to his native country. He returned to London in the latter end of that year; died greatly beloved and reſpected January 18. 1782; and having no children, was ſucceeded in eſtate, and alſo (agreeably to the limitation of the patent) in title, by his nephew, now Sir James Pringle, Bart. Among this worthy phyſician's communications to the Royal Society, the following are the principal: 1. "Some Experiments on Subſtances reſiſting Putrefaction," Phil. Tranſ. N° 495, p. 580; and N° 496, p. 525, 550; reprinted, with additions, in Martin's Abridgment, vol. xi. p. 1365. 2. "Account of ſome Perſons ſeized with the Gaol Fever by working in Newgate, and of the manner by which the Infection was communicated to one entire Family," vol. xlviii. p. 42. At the requeſt of Dr Hales, a copy of this uſeful paper was inſerted in the Gentleman's Magazine, 1753, p. 71, before its appearance in the Tranſactions. 3. "A remarkable Caſe of Fragility, Flexibility, and Diſſolution of the Bones," ib. p. 297. 4. "Account of the Earthquakes felt at Bruſſels," vol. xlix. p. 546. 5. "Account of ſinking of a River near Pontypool, in Monmouthſhire," ib. p. 547. 6. "Account of an Earthquake felt Feb. 18. 1756, along the coaſt of England, between Margate and Dover," ib. p. 579. 7. "Account of the Earthquake felt at Glaſgow and Dumbarton; alſo of a Shower of Duſt falling on a Ship between Shetland and Iceland," ib. p. 509. 8. "Several Accounts of the Fiery Meteor which appeared on Sunday, November 26. 1758, between eight and nine at night," vol. l. p. 218. 9. "Account of the Virtues

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Prinos ‖ Printing.

tues of Soap in diſſolving the Stone, in the Caſe of the Reverend Mr Matthew Simſon," ib. p. 221. 10. "Account of the Effects of Electricity in Paralytic Caſes," ib. p. 481. And ſee a letter to him on that ſubject from *Profeſſor* Winthorp. "Some Account of the Succeſs of the *Vitrum Ceratum Antimonii*," was printed in the Edinburgh Medical Eſſays, vol. v.

PRINOS, in botany: A genus of the monogynia order, belonging to the hexandria claſs of plants; and in the natural method ranking under the 43d order, *Dumoſæ*. The calyx is ſexfid; the corolla monopetalous, and rotaceous; the belly hexaſpermous.

PRINTER, a perſon who compoſes and takes impreſſions from moveable characters ranged in order, by means of ink, and a preſs.

PRINTING, the art of taking impreſſions from characters or figures, moveable and immoveable, on paper, linen, ſilk, &c. There are three kinds of printing: the one from moveable letters, for books; another from copper-plates, for pictures; and the laſt from blocks, in which the repreſentation of birds, flowers, &c. are cut, for printing calicoes, linen, &c. The firſt is called *common* or *letter-preſs* printing; the ſecond, *rolling-preſs* printing; and the laſt, *calico*, &c. printing. The principal difference between the three conſiſts in this, that the firſt is caſt in relievo, in diſtinct pieces; the ſecond engraven in creux; and the third cut in relievo, and generally ſtamped, by placing the block upon the materials to be printed, and ſtriking upon the back of it.

1 Letter-preſs printing.

Of the above branches, LETTER-PRESS PRINTING is the moſt curious, and deſerves the moſt particular notice: for to it are owing chiefly our deliverance from ignorance and error, the progreſs of learning, the revival of the ſciences, and numberleſs improvements in arts, which, without this noble invention, would have been either loſt to mankind, or confined to the knowledge of a few. "To the art of printing (ſays an elegant eſſayiſt*), it is acknowledged we owe the reformation. It has been juſtly remarked, that if the books of Luther had been multiplied only by the ſlow proceſs of the hand-writing, they muſt have been few, and would have been eaſily ſuppreſſed by the combination of wealth and power: but, poured forth in abundance from the preſs, they ſpread over the land with the rapidity of an inundation, which acquires additional force from the efforts uſed to obſtruct its progreſs. He who undertook to prevent the diſperſion of the books once iſſued from the preſs, attempted a taſk no leſs arduous than the deſtruction of the hydra. Reſiſtance was vain, and religion was reformed: and we who are chiefly intereſted in this happy revolution muſt remember, amidſt the praiſes beſtowed on Luther, that his endeavours had been ineffectual, unaſſiſted by the invention of Fauſtus.

2 Utility of this art. **Dr Knox.*

3 Good and evil reſulting from it.

"How greatly the cauſe of religion has been promoted by the art, muſt appear, when it is conſidered, that it has placed thoſe ſacred books in the hand of every individual, which, beſides that they were once locked up in a dead language, could not be procured without great difficulty. The numerous comments on them of every kind, which tend to promote piety, and to form the Chriſtian philoſopher, would probably never have been compoſed, and certainly would not have extended their beneficial influence, if typography had ſtill been unknown. By that art, the light, which is to illuminate a dark world, has been placed in a ſituation more advantageous to the emiſſion of its rays: but if it has been the means of illuſtrating the doctrines, and enforcing the practice of religion, it has alſo, particularly in the preſent age, ſtruck at the root of piety and moral virtue, by propagating opinions favourable to the ſceptic and the voluptuary. It has enabled modern authors wantonly to gratify their avarice, their vanity, and their miſanthropy, in diſſeminating novel ſyſtems ſubverſive of the dignity and happineſs of human nature: but though the perverſion of the art is lamentably remarkable in thoſe volumes which iſſue, with offenſive profuſion, from the vain, the wicked, and the hungry, yet this good reſults from the evil, that as truth is great and will prevail, ſhe muſt derive freſh luſtre, by diſplaying the ſuperiority of her ſtrength in the conflict with ſophiſtry. Printing.

"Thus the art of printing, in whatever light it is viewed, has deſerved reſpect and attention. From the ingenuity of the contrivance, it has ever excited mechanical curioſity; from its intimate connection with learning, it has juſtly claimed hiſtorical notice; and from its extenſive influence on morality, politics, and religion, it is now become a ſubject of very important ſpeculation.

4 Its good effects overbalance the bad.

"But however we may felicitate mankind on the invention, there are perhaps thoſe who wiſh, that, together with its compatriot art of manufacturing gunpowder, it had not yet been brought to light. Of its effects on literature, they aſſert, that it has increaſed the number of books, till they diſtract rather than improve the mind; and of its malignant influence on morals, they complain, that it has often introduced a falſe refinement, incompatible with the ſimplicity of primitive piety and genuine virtue. With reſpect to its literary ill conſequences, it may be ſaid, that though it produces to the world an infinite number of worthleſs publications, yet true wit and fine compoſition will ſtill retain their value, and it will be an eaſy taſk for critical diſcernment to ſelect theſe from the ſurrounding maſs of abſurdity: and though, with reſpect to its moral effects, a regard to truth extorts the confeſſion, that it has diffuſed immorality and irreligion, divulged with cruel impertinence the ſecrets of private life, and ſpread the tale of ſcandal through an empire; yet theſe are evils which will either ſhrink away unobſerved in the triumphs of time and truth over falſehood, or which may, at any time, be ſuppreſſed by legiſlative interpoſition."

5 Hiſtory of the invention of printing.

Some writers have aſcribed the origin of this art to the Eaſt, and affixed a very early period to its invention; particularly P. Jovius, (*Hiſt.* lib. xiv. p. 226. ed. Florent. 1550), from whom Oſorius and many others have embraced the ſame opinion. But theſe have evidently confounded the European mode of printing with the *engraved tablets* which to this day are uſed in China. The invention of theſe tablets has been aſcribed by many writers even to an earlier period than the commencement of the Chriſtian era; but is with more probability aſſigned, by the very accurate Phil. Couplet, to the year 930. The *Hiſtoria Sinenſis* of Abdalla, written in Perſic in 1317, ſpeaks of it as an art in very common uſe. MEERMAN, vol. i. p. 16. 218, 219, vol. ii. p. 186. N. Trigault aſſerts that the Chineſe practiſed the art of printing

Printing. printing five centuries before. Count Ferre Rezzonico found at Lyons plates with words and names engraven by a Nuremberger 1380.

The honour of having given riſe to the European method has been claimed by the cities of *Harlem*, *Mentz*, and *Straſburg*. And to each of theſe it may be aſcribed in a qualified ſenſe, as they made improvements upon one another.

6 Claim of Harlem. I. The firſt teſtimony of the inventor is that recorded by Hadrian Junius, in his *Batavia*, p. 253, ed. Lugd. Bat. 1588; which, though it hath been rejected by many, is of undoubted authority. Junius had the relation from two reputable men; Nicolaus Galius (A), who was his ſchoolmaſter; and Quirinius Taleſius, his intimate and correſpondent. He aſcribes it to LAURENTIUS, the ſon of John (Ædituus, or Cuſtos, of the cathedral at HARLEM, at that time a reſpectable office), upon the teſtimony of Cornelius, ſome time a ſervant to Laurentius, and afterwards bookbinder to the cathedral, an office which had before been performed by Franciſcan friars. His narrative was thus: "That, walking in a wood near the city (as the citizens of opulence uſe to do), he began at firſt to cut ſome letters upon the rind of a beech-tree; which, for fancy's ſake, being impreſſed on paper, he printed one or two lines, as a ſpecimen for his grand-children (the ſons of his daughter) to follow. This having happily ſucceeded, he meditated greater things (as he was a man of ingenuity and judgment); and firſt of all, with his ſon-in-law Thomas Peter (who, by the way, left three ſons, who all attained the conſular dignity), invented a more glutinous writing-ink, becauſe he found the common ink ſunk and ſpread; and then formed whole pages of wood, with letters cut upon them; of which ſort I have ſeen ſome eſſays, in an anonymous work, printed only on one ſide, intitled, *Speculum noſtræ ſalutis*; in which it is remarkable, that in the infancy of printing (as nothing is complete at its firſt invention) the back ſides of the pages were paſted together, that they might not by their nakedneſs betray their deformity. Theſe beechen letters he afterwards changed for leaden ones, and theſe again for a mixture of tin and lead [*ſtanneas*] as a leſs flexible and more ſolid and durable ſubſtance. Of the remains of which types, when they were turned to waſte metal, thoſe old wine-pots were caſt, that are ſtill preſerved in the family-houſe, which looks into the market-place, inhabited afterwards by his great-grandſon Gerard Thomas, a gentleman of reputation; whom I mention for the honour of the family, and who died old a few years ſince. A new invention never fails to engage curioſity. And when a commodity never before ſeen excited purchaſers, to the advantage of the inventor, the admiration of the art increaſed, dependents were enlarged, and workmen multiplied; the firſt calamitous incident! Among theſe was one John, whether, as we ſuſpect, he had ominouſly the name of *Fauſtus* (B), unfaithful and unlucky to his maſter, or whether it was really a perſon of that name, I ſhall not much inquire; being unwilling to moleſt the ſilent ſhades, who ſuffer from a conſciouſneſs of their paſt actions in this life. This man, bound by oath to keep the ſecret of printing, when he thought he had learned the art of joining the letters, the method of caſting the types, and other things of that nature, taking the moſt convenient time that was poſſible, on Chriſtmas eve, when every one was cuſtomarily employed in luſtral ſacrifices, ſeizes the collection of types, and all the implements his maſter had got together, and, with one accomplice, marches off to Amſterdam, thence to Cologne, and at laſt ſettled at Mentz, as at an aſylum of ſecurity, where he might go to work with the tools he had ſtolen. It is certain, that in a year's time, viz. in 1442, the *Doctrinale* of Alexander Galius, which was a grammar much uſed at that time, together with the *Tracts* of Peter of Spain, came forth there, from the ſame types as Laurentius had made uſe of at Harlem."

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Thus far the narrative of Junius, which he had frequently heard from Nicolaus Galius; to whom it was related by Cornelius himſelf, who lived to a great age, and uſed to burſt into tears upon reflecting on the loſs his maſter had ſuſtained, not only in his ſubſtance, but in his honour, by the roguery of his ſervant, his former aſſociate and bedfellow. Cornelius, as appears by the regiſters of Harlem cathedral, died either in 1515, or the beginning of the following year; ſo that he might very well give this information to Nicolaus Galius, who was ſchoolmaſter to Hadrian Junius.

Though this circumſtance is probable as to the main fact, yet we muſt ſet aſide the evidence of it in ſome particulars. 1. The firſt obvious difficulty is noticed by Scriverius; "that the types are ſaid to be made of the *rind* of beach, which could not be ſtrong enough to bear the impreſſion of the preſs:" though this is removed, if, inſtead of the *bark*, we ſubſtitute a *bough* of the beach. The idea of the *bark*, when Junius wrote this, was perhaps ſtrong in his mind, from what Virgil tells us (Ecl. v. 13.) of its being uſual to cut words on the *bark* of a beech; and thence he was eaſily led to make a wrong application of it here. *Bower and Nichols's Origin of Printing.*

2. The letters were at firſt *wooden*, and are ſaid to be afterwards exchanged for *metal* types; from which the wine-pots were formed, remaining in the time of Junius. According to tradition, printing was carried on in the ſame houſe long after the time of Laurentius: theſe pots might therefore be formed from the waſte metal of the printing-houſe, after the uſe of *fuſile types* became univerſal.—But Laurentius ſeems to have carried the art no farther than *ſeparate wooden types*. What is a remarkable

(A) Galius ſeems to be the ſame who is called *Claes Lottynſz. Gael.* Scabinus Harlemi, as it is in the Faſti of that city, in the years 1531, 1533, and 1535. Quirinius in the ſame Faſti is called *Mr Quiryn Dirkſzoon.* He was many years amanuenſis to the great Eraſmus, as appears from his epiſtle, 23d July 1529. tom. iii. Oper. p. 1222. He was afterwards Scabinus in 1537 & ſeq. and Conſul in 1552 & ſeq. But in the troubles of Holland he was cruelly killed by the Spaniſh ſoldiers, May 23. 1573. There are ſome letters of Hadrian Junius to this Taleſius, in the *Epiſtolæ Junianæ*, p. 198.

(B) *John Fauſt*, or *Fuſt*, is by many ſuppoſed to have derived his name from *fauſtus*, "happy;" and Dr Fauſtus ſeems to carry an air of grandeur in the appellation: but very erroneouſly. *John Fauſt*, or *Fuſt*, is no more than *John Hand*, whence our name *Fiſt*.

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remarkable confirmation of this, Henry Spiechel, who wrote, in the 16th century, a Dutch poem intitled *Hertſpiegel*, expreſſes himſelf thus: "Thou firſt, Laurentius, to ſupply the defect of wooden tablets, adaptedſt *wooden types*, and afterwards didſt connect them with a thread, to imitate writing. A treacherous ſervant ſurreptitiouſly obtained the honour of the diſcovery. But truth itſelf, though deſtitute of common and wide-ſpread fame; truth, I ſay, ſtill remains." No mention in the poem of *metal types*; a circumſtance which, had he been robbed of ſuch, as well as of *wooden* ones, would ſcarcely have been paſſed over in ſilence.

When Laurentius firſt deviſed his rough ſpecimen of the art, can only be gueſſed at. He died in 1440, after having publiſhed the *Speculum Belgicum*, and two editions of *Donatus*, all with different *wooden types*; which it is probable (conſidering the difficulties he had to encounter, and the many artiſts whom he muſt neceſſarily have had occaſion to conſult) coſt him ſome years to execute; ſo that the firſt eſſay might be about 1430, which nearly agrees with Petrus Scriverius, who ſays the invention was about 10 or 12 years before 1440. See LAURENTIUS.

3. What was the ſpecimen he firſt diverted himſelf with in cutting, at the diſtance of three centuries, one would think impoſſible to be diſcovered. And yet Joh. Enſchedius, a printer, thinks he was ſo happy as to find it, being an old parchment *Horarium*, printed on both ſides, in eight pages, containing the Letters of the Alphabet, the Lord's Prayer, the Apoſtles Creed, and three ſhort prayers. And Mr Meerman having ſhown this to proper artiſts who were judges of theſe matters, they gave it as their opinion that it agreed exactly with the deſcription of Junius. It is conformable to the firſt edition of the Dutch *Speculum Salvationis*, and the fragments of both *Donatus's* of Holland, both which are the works of the ſame Laurentius, and were preceded by this. In theſe types, which are certainly moveable, cut, and uneven, there is a rudeneſs which Mr Meerman has not obſerved in any other inſtances. There are no numbers to the pages, no ſignatures, no *direction-words*, no diviſions at the end of the lines; on the contrary, a ſyllable divided in the middle is ſeen, thus, *Sp iritū*, in p. 8. l. 2, 3. There are neither diſtinctions nor points, which are ſeen in the other works of Laurentius; and the letter *i* is not marked with an accent, but with a dot at the top. The lines throughout are uneven. The ſhape of the pages not always the ſame; not (as they ſhould be) rectangular, but ſometimes rhomb-like, ſometimes an *iſoſcele trapezium*; and the performance ſeems to be left as a ſpecimen both of his piety, and of his ingenuity in this eſſay of a new invented art. Mr Meerman has given an exact engraving of this ſingular curioſity.

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But, whatever elſe may appear doubtful in the narrative of Junius, it is very clear, that the firſt eſſays of the art are to be attributed to Laurentius, who uſed only *ſeparate wooden types*. See the article LAURENTIUS.

7 Claim of Mentz.

II. Some of Laurentius's types were ſtolen from him by one of his ſervants (c), *John* GEINSFLEICH *ſenior*; who fled therewith to MENTZ. Having introduced the

(c) Authors differ as to the perſon who committed this robbery. It is clear from all accounts that his name was *John*; but what his ſurname was is the diſputed point. Junius, after ſome heſitation, aſcribes it to John Fuſt; but with injuſtice: for he was a wealthy man, who aſſiſted the firſt printers at Mentz with money; and though he afterwards was proprietor of a printing-office, yet he never, as far as appears, performed any part of the buſineſs with his own hands, and conſequently he could never have been a ſervant to Laurentius. Nor is the conjecture of Scriverius better founded, which fixes it upon John Gutenberg, who (as appears by authentic teſtimonies) reſided at Straſburg from 1436 to 1444, and during all that period employed much fruitleſs labour and expence in endeavouring to attain this art. Mr Meerman once thought, "it might be either John Meidenbachius, (who, we are told by Seb. Munſter and the author of *Chronographia Moguntinenſis*, was an aſſiſtant to the firſt Mentz printers); or John Peterſheimius (who was ſome time a ſervant to Fuſt and Schoeffer, and ſet up a printing-houſe at Francfort in 1459): or, laſtly, ſome other perſon, who, being unable through poverty to carry on the buſineſs, diſcovered it to *Geinſfleich* at Mentz." But more authentic intelligence afterwards convinced him there were two perſons of this name; and that John Geinsfleich ſenior * was the diſhoneſt ſervant, who was born at Mentz, and who in the papers publiſhed by Kohlerus, we find there in the year 1441, and not before: for though he was of a good family, yet he was poor, and ſeems to have been obliged, as well as his brother, to ſeek his livelihood in a foreign country; and perhaps was content to be under Laurentius, that, when he had learned the art, he might follow it in his own. But, to leave conjecture, we may produce ſome certain teſtimonies.

1. It is what Junius himſelf ſays, that the perſon who ſtole the types did it with a view to ſet up elſewhere; nor is it likely that he would either make no uſe of an art he had ſeen ſo profitable to Laurentius, or that he would teach it to another and ſubmit to be again a ſervant.

2. The Lambeth Record (which is printed below, from Mr Atkyns) tells us, that "Mentz gained the art by the brother of one of the workmen of Harlem, who learned it at home of his brother, who after ſet up for himſelf at Mentz."—By the ſtricteſt examination of the beſt authorities, it is plain, that by theſe *two brothers* the two Geinsfleiches muſt be meant. But as the younger (*Gutenberg*) was never a ſervant to Laurentius, it muſt be the ſenior who carried off the types, and inſtructed his brother in the art; who firſt applied himſelf to the buſineſs at Straſburg, and afterwards joined his elder brother, who had in the mean time ſettled at Mentz.

* He was called *Geinſfleich* κατ' ἐξοχήν; the other was diſtinguiſhed by the name of *Gutenberg*. They were both poor; though of a family diſtinguiſhed by knighthood. They were both married men; and were moſt probably brothers, as it was not uncommon in that age for two brothers to have the ſame Chriſtian name. Theſe both appear in a diſreputable light. The eldeſt robbed his maſter, with many aggravating circumſtances. The youngeſt was remarkably contentious; and, after entering into a contract of marriage with Anna, a noble girl of *The Iron Gate*, refuſed to marry her till compelled by a judicial decree; and afterwards cared not what became of the lady, but left her behind at Straſburg when he removed to Mentz. He had not only frequent quarrels with his wife; but with *Andrew Drizehen*, *Andrew Heilmann*, and *John Riff*, all of whom were aſſociated with him at Straſburg in his different employments of making of looking glaſſes, poliſhing of precious ſtones, and endeavouring to attain the art of printing; and with theſe he involved himſelf in three law-ſuits. See *Meerman*, vol. I. p. 163, &c. N.

What

Printing. the art from Harlem into this his native city, he ſet with all diligence to carry it on; and publiſhed, in 1442, *Alexandri Galli Doctrinale*, and *Petri Hispani Tractatus*; two works, which, being ſmall, beſt ſuited his circumſtances; and for which, being much uſed in the ſchools, he might reaſonably expect a profitable ſale. They were executed with *wooden types*, cut after the model of thoſe he had ſtolen.

In 1443 he hired the houſe Zum Jungen; and was aſſiſted with money by Fust, a wealthy perſon, who in return had a ſhare of the buſineſs: and about the ſame time *John Meidenbachius* was admitted a partner, as were ſome others whoſe names are not tranſmitted to our times; and in 1444 they were joined by Gutenberg, who for that purpoſe quitted Straſburg. Wooden types being found not ſufficiently durable, and not anſwering expectation in other reſpects, the two brothers firſt invented *cut metal types*. But while theſe were preparing, which muſt have been a work of time, ſeveral works were printed, both on *wooden ſeparate types* and on *wooden blocks*; which were well adapted to ſmall books of frequent uſe, ſuch as the *Tabula Alphabetica*, the *Catholicon*, *Donati Grammatica*, and the *Confeſſionalia*.

From the above-mentioned printers in conjunction, after many ſmaller eſſays, the Bible was publiſhed in 1450, with *large cut metal types* (D). And it is no wonder, conſidering the immenſe labour this work coſt, that it ſhould be ſeven or eight years in completing. In this ſame year the partnerſhip was diſſolved, and a new one entered into, in Auguſt, between *Fuſt and Gutenberg*; the former ſupplying the money, the latter ſkill, for their common benefit. Various difficulties ariſing, occaſioned a law-ſuit for the money which Fuſt had advanced; which was determined againſt Gutenberg. A diſſolution of this partnerſhip enſued in 1455; and in 1457 a magnificent edition of the Pſalter was publiſhed by *Fuſt and Schoeffer*, with a remarkable commendation, in which they aſſumed to themſelves the merit of a new invention, (viz of *metal types*), *ad inventionem artificioſam imprimendi ac characterizandi*. This book was uncommonly elegant, and in ſome meaſure the work of Gutenberg; as it was four years in the preſs, and came out but 18 months after the partnerſhip was diſſolved between him and Fuſt.

The latter continued in poſſeſſion of the printing-office: and *Gutenberg*, by the pecuniary aſſiſtance of Conrad Humery ſyndic of Mentz (E), and others, opened another office in the ſame city; whence appeared, in 1460, without the printer's name, the *Catholicon Jo. de Janua*, with a pompous colophon in praiſe of its beauty, and aſcribing the honour of the invention to the city of Mentz. It was a very handſome book, though inferior to the Pſalter which had been publiſhed in 1457 by Fuſt and Schoeffer. Both the Pſalter and *Catholicon* were printed on *cut metal types* (F). It may not be improper to obſerve here, that as the Pſalter is the earlieſt book which is known to have a genuine date, it became a common practice, after that publication, for printers to claim their own performances, by adding their names to them.

III. The progreſs of the art has been thus traced

What is ſtill ſtronger, two chronologers of Straſburg, the one named *Dan Speklinus*, the other anonymous (in Meerman's *Documenta*, n° LXXXV. LXXXVI.), tells us expreſsly, that John Geinsfleich (viz. the ſenior, whom they diſtinguiſhed from Gutenberg), having learned the art by being ſervant to its *firſt inventor*, carried it by theft into Mentz his native country. They are right in the fact, though miſtaken in the application of it; for they make Straſburg the place of the invention, and Mentelius the inventor, from whom the types were ſtolen. But this is plainly an error: for Geinsfleich lived at Mentz in 1441, as appears from undoubted teſtimonies; and could not be a ſervant to Mentelius, to whom the before mentioned writers aſcribe the invention in 1440, though more ancient ones do not attempt to prove that he began to print before 1444 or 1447. Nor will the narrative agree better with Gutenberg, who was an earlier printer than Mentelius; ſince, among the evidences produced by him in his law-ſuit, 1439, no Geinsfleich ſenior appears, nor any other ſervant but Laurentius Beildek. The narration therefore of the theft of Geinsfleich, being ſpread by various reports through the world, and ſubſiſting in the time of theſe chronologers, was applied by them (to ſerve the cauſe they wrote for) to Straſburg; but ſerves to confirm the truth, ſince no writer derives the printing ſpoils from any other country than Holland or Alſatia. The chronologers have likewiſe, inſtead of Fuſt, called Gutenberg the wealthy man; who, from all circumſtances, appears to have been poor. They alſo call Schoeffer the ſon-in-law of Mentelius; when it is clear that he married the daughter of Fuſt.

(D) Many writers have ſuppoſed that this was the edition of which ſome copies were ſold in France, by Fuſt, as manuſcripts, for the great price of 500 or 600 crowns, which he afterwards lowered to 60, and at laſt to leſs than 40. But it was the ſecond and more expenſive edition of 1462, that was thus diſpoſed of, when Fuſt went to Paris in 1466, and which had coſt 4000 florins before the third *quaternion* (or quire of four ſheets) was printed. Meerman, vol. I. p. 6. 151, 152.

(E) At the death of Gutenberg, Conrad Humery took poſſeſſion of all his printing materials; and engaged to the archbiſhop Adolphus, that he never would ſell them to any one but a citizen of Mentz. They were, however, ſoon diſpoſed of to Nicholas Bechtermuntze of Altavilla, who, in 1469, publiſhed *Vocabularium Latino-Teutonicum*, which was printed with the ſame types which had been uſed in the *Catholicon*. This very curious and ſcarce *Vocabulary* was ſhown to Mr Meerman, by Mr Bryant, in the Duke of Marlborough's valuable library at Blenheim. It is in quarto, 35 lines long, contains many extracts from the *Catholicon*, and is called *Ex quo*, from the preface beginning with thoſe words. Meerman, vol. II. p. 96.

(F) Gutenberg never uſed any other than either *wooden* or *cut metal types* till the year 1462. In 1465 he was admitted *inter Aulicos* by the elector Adolphus, with an annual penſion; and died in February 1468. His elder brother Geinsfleich died in 1462. Their epitaphs are printed by Mr Meerman, vol. II. p. 154, 295.

Printing. through its *ſecond* period, the invention of *cut metal types*. But the honour of completing the diſcovery is due to PETER SCHOEFFER (G) de Gernſheim.

8 Invention of caſt types. A very clear account of this final completion of the types is preſerved by Trithemius (H). *Poſt hæc inventis ſucceſſerunt ſubtiliora, inveneruntque modum* fundendi formas *omnium Latini alphabeti literarum, quas ipſi* matrices *nominabant: ex quibus rurſum æneos ſive ſtanneos characteres fundebant, ad omnem preſſuram ſufficientes, quos prius manibus ſculpebant. Et revera ſicuti* ante *xxx* ferme annos *ex ore Petri Opilionis de Gernſheim, civis Moguntini, qui gener erat primi artis inventoris, audivi, magnam a primo inventionis ſuæ hæc ars impreſſoria habuit difficultatem.—Petrus autem memoratus Opilio, tunc famulus poſtea gener, ſicut diximus, inventoris primi, Johannis Fuſt, homo ingenioſus et prudens, faciliorem modum* fundendi characteres *excogitavit, et artem, ut nunc eſt, complevit.*

Another ample teſtimony in favour of Schoeffer is given by Jo. Frid. Fauſtus of Aſchaffenburg, from papers preſerved in his family: "Peter Schoeffer of Gernſheim, perceiving his maſter Fuſt's deſign, and being himſelf ardently deſirous to improve the art, found out (by the good providence of God) the method of cutting *(incidendi)* the characters in a *matrix*, that the letters might eaſily be ſingly *caſt*, inſtead of being *cut*. He privately *cut matrices* for the whole alphabet; and when he ſhowed his maſter the letters caſt from theſe matrices, Fuſt was ſo pleaſed with the contrivance, that he promiſed Peter to give him his only daughter, Chriſtina, in marriage; a promiſe which he ſoon after performed. But there were as many difficulties at firſt with theſe letters, as there had been before with *wooden* ones; the metal being too ſoft to ſupport the force of the impreſſion: but this defect was ſoon remedied, by mixing the metal with a ſubſtance which ſufficiently hardened it (I)."

Fuſt and Schoeffer concealed this new improvement, by adminiſtering an oath of ſecrecy to all whom they intruſted, till the year 1462; when, by the diſperſion of their ſervants into different countries, at the ſacking of Mentz by the archbiſhop Adolphus, the invention was publicly divulged.

The firſt book printed with theſe *improved types* was *Durandi Rationale*, in 1459; at which time, however, they ſeem to have had only *one ſize* of *caſt* letters, all the larger characters which occur being *cut types*, as appears plainly by an inſpection of the book. From this time to 1466, Fuſt and Schoeffer continued to print a conſiderable number of books; particularly two famous editions of *Tully's Offices*. In their earlieſt books, they printed more copies on *vellum* than on *paper*, which was the caſe both of their *Bibles* and *Tully's Offices*. This, however, was ſoon inverted; and *paper* introduced for the greateſt part of their impreſſions; a few only being printed on *vellum* for curioſities, and for the purpoſe of being *illuminated*. How long Fuſt lived, is uncertain; but in 1471 we find Schoeffer was in partnerſhip with *Conrad Henlif* and a kinſman of his maſter Fuſt. He publiſhed many books after the death of his father-in-law; the laſt of which that can be diſcovered is a third edition of the *Pſalter* in 1490, in which the old *cut* types of the firſt edition were uſed. Printing.

9 Claim of Straſburg. IV. With regard to the claim of STRASBURG: It has been already mentioned, that Gutenberg was engaged in that city in different employments; and, among others, in endeavouring to attain the art of printing. That theſe endeavours were unſucceſsful, is plain from an authentic judicial decree of the ſenate of Straſburg in 1439, after the death of Andrew Drizehen (K).

But there are many other proofs that Gutenberg and his partners were never able to bring the art to perfection.

1. Wimphelingius*, the oldeſt writer in favour of Straſburg, tells us, that Gutenberg was the inventor of "a new art of writing," *ars impreſſoria*, which might alſo be called a *divine benefit*, and which he happily completed at Mentz; but does not mention one book of his printing: though he adds, that Mentelius printed many volumes correctly and beautifully, and acquired great wealth; whence we may conclude that he perfected what Gutenberg had in vain eſſayed.

2. Wimphelingius, in another book†, tells us, the art of printing was found out by Gutenberg *incomplete*; which implies, not that he practiſed the art in an imperfect manner (as Laurentius had done at Harlem), but rather that he had not been able to accompliſh what he aimed at.

3. Gutenberg, when he left Straſburg in 1444 or the

* *Epitome Rerum Germanicarum* ed Argent. 1505, Meerman, vol. i. p. 202. vol. ii. p. 139.

† *Catal. Epiſc. Argent.* 1508, *Meerman*, ut ſupra.

(G) In German, Schoeffer; in Latin, *Opilio*; in Engliſh, *Shepherd*.——He is ſuppoſed by Mr Meerman to have been the firſt engraver on copperplates.

(H) *Annales Hirſaugienſes*, tom. ii. ad ann. 1450.—As this book was finiſhed in 1514, and Trithemius tells us he had the narrative from Schoeffer himſelf about 30 years before; this will bring us back to 1484, when Schoeffer muſt have been advanced in years, and Trithemius about 22 years old, who died in 1516. See *Voſſ.* Hiſt. Lat. l. 1. c. 10. *Fabr.* Med. & Infim. Æt. l. 9.

(I) See *Meerman*, vol. I. 9. 183. who copied this teſtimony from Wolfius, *Monument. Typograph.* vol. i. p. 468. ſeq.

(K) Their firſt attempts were made about 1436 with *wooden types*. Mr Meerman is of opinion that Geinsfleich junior (who was of an enterpriſing genius, and had already engaged in a variety of projects) gained ſome little inſight into the buſineſs by viſiting his brother who was employed by Laurentius at Haerleim, but not ſufficient to enable him to practiſe it. It is certain that, at the time of the law-ſuit in 1439, much money had been expended, without any profit having ariſen; and the unfortunate Drizehen, in 1438, on his death-bed, lamented to his confeſſor, that he had been at great expence, without having been reimburſed a ſingle *obolus*. Nor did Gutenberg (who perſiſted in his fruitleſs endeavours) reap any advantage from them; for, when he quitted Straſburg, he was overwhelmed in debt, and under a neceſſity of ſelling every thing he was in poſſeſſion of. [MEERMAN, vol. I. p. 198—202.] All the depoſitions in the law-ſuit above-mentioned (with the judicial decree) are printed by Mr Meerman, vol. II. p. 58—88. N.

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the following year, and entered into partnerſhip with Geinsfleich ſenior and others, had occaſion for his brother's aſſiſtance to enable him to complete the art; which ſhows that his former attempts at Straſburg had been unſucceſsful ‡.

‡ *Meerman*, ut ſupra.

4. Theſe particulars are remarkably confirmed by Trithemius, who tells us, in two different places ‖, that Gutenberg ſpent all his ſubſtance in queſt of this art; and met with ſuch inſuperable difficulties, that, in deſpair, he had nearly given up all hopes of attaining it, till he was aſſiſted by the liberality of Fuſt, and by his brother's ſkill, in the city of Mentz.

‖ *Annal. Hirſaug.* ut ſupra, *et Chron. Spanheim.* See *Meerman*, vol. ii. p. 103. 127.

5. Ulric Zell ſays * the art was completed at Mentz; but that ſome books had been publiſhed in Holland earlier than in that city. Is it likely that Zell, who was a German, would have omitted to mention Straſburg, if it had preceded Mentz in printing?

* *Chronicon Coloniæ*, 1499.

There is little doubt therefore that all Gutenberg's labours at Straſburg amounted to no more than a fruitleſs attempt, which he was at laſt under the neceſſity of relinquiſhing: and there is no certain proof of a ſingle book having been printed in that city till after the diſperſion of the printers in 1462, when Mentelius and Eggeſtenius ſucceſsfully purſued the buſineſs.

In fine, the pretenſions of *Straſburg* fall evidently to be ſet aſide. And as to the other two cities, *Harlem* and *Mentz*, the diſputes between them ſeem eaſily cleared up, from the twofold invention of printing abovementioned: the firſt with *ſeparate* WOODEN *types* at Harlem, by Laurentius, about 1430, and after continued by his family; the other with METAL *types*, firſt *cut*, and afterwards *caſt*, which were invented at Mentz, but not uſed in Holland till brought thither by Theodoric Martens at Aloſt about 1472.

From this period printing made a rapid progreſs in moſt of the principal towns of Europe. In 1490, it reached Conſtantinople; and, according to Mr Palmer, p. 281, &c. it was extended, by the middle of the next century, to Africa and America. It was introduced into Ruſſia about 1560: but, from motives either of policy or ſuperſtition, it was ſpeedily ſuppreſſed by the ruling powers; and, even under the preſent enlightened empreſs, has ſcarcely emerged from its obſcurity.—That it was early practiſed in the inhoſpitable regions of Iceland, we have the reſpectable authority of Mr Bryant: "Arngrim Jonas was born amidſt the ſnows of Iceland; yet as much prejudiced in favour of his country as thoſe who are natives of an happier climate. This is viſible in his *Crymogæa*; but more particularly in his *Anatome Bleſkiniana*. I have in my poſſeſſion this curious little treatiſe, written in Latin by him in his own country, and printed *Typis Holenſibus in Iſlandiâ Boreali*, *anno* 1612. *Hola* is placed in ſome maps within the Arctic circle, and is certainly not far removed from it. I believe it is the fartheſt north of any place where arts and ſciences have ever reſided." *Obſervations and Inquiries relating to various parts of Ancient Hiſtory*, 1767, p. 277.

10 Introduction of the art into Britain.

It was a conſtant opinion, delivered down by our hiſtorians, as hath been obſerved by Dr Middleton, that the Art of Printing was introduced and firſt practiſed in England by *William Caxton*, a mercer and citizen of London; who, by his travels abroad, and a reſidence of many years in Holland, Flanders, and Germany, in the affairs of trade, had an opportunity of informing himſelf of the whole method and proceſs of the art; and by the encouragement of the great, and particularly of the abbot of Weſtminſter, firſt ſet up a preſs in that abbey, and began to print books ſoon after the year 1471. Printing.

This was the tradition of our writers; till a book, which had ſcarce been obſerved before the Reſtoration, was then taken notice of by the curious, with a date of its impreſſion from Oxford, *anno* 1468, and was conſidered immediately as a clear proof and monument of the exerciſe of printing in that univerſity ſeveral years before Caxton began to deal in it.

This book, which is in the public library at Cambridge, is a ſmall volume of 41 leaves in 4to, with this title: *Expoſitio Sancti Jeronimi in Simbolum Apoſtolorum ad Papam Laurentium:* and at the end, *Explicit expoſitio, &c. Impreſſa Oxonie, & finita Anno Domini* M.CCCC.LXVIII. XVII *die Decembris*.

It

The firſt printing-preſs ſet up in England was at Oxford.

The appearance of this book has robbed Caxton of a glory that he had long poſſeſſed, of being the author of printing in this kingdom; and Oxford has ever ſince carried the honour of the firſt preſs. The only difficulty was, to account for the ſilence of hiſtory in an event ſo memorable, and the want of any memorial in the univerſity itſelf concerning the eſtabliſhment of a new art amongſt them of ſuch uſe and benefit to learning. But this likewiſe has been cleared up by the diſcovery of a record, which had lain obſcure and unknown at Lambeth-palace, in the Regiſter of the See of Canterbury; and gives a narrative of the whole tranſaction, drawn up at the very time.

An account of this record was firſt publiſhed in a thin quarto volume, in Engliſh; with this title: "The Original and Growth of Printing, collected out of Hiſtory and the Records of this Kingdome: wherein is alſo demonſtrated, that Printing appertaineth to the Prerogative Royal, and is a Flower of the Crown of England. By Richard Atkyns, eſq.—Whitehall, April the 25. 1664. By order and appointment of the right honourable Mr Secretary Morrice, let this be printed. Tho. Rycaut. London: Printed by John Streater, for the Author. 1664." 4to.

It ſets forth in ſhort, "That as ſoon as the art of printing made ſome noiſe in Europe, Thomas Bourchier, archbiſhop of Canterbury, moved the then king (Henry VI.) to uſe all poſſible means for procuring a printing-mould (for ſo it was then called) to be brought into this kingdom. The king (a good man, and much given to works of this nature) readily hearkened to the motion; and, taking private advice how to effect his deſign, concluded it could not be brought about without great ſecrecy, and a conſiderable ſum of money given to ſuch perſon or perſons as would draw off ſome of the workmen of Harlem in Holland, where John Gutenberg had newly invented it, and was himſelf perſonally at work. It was reſolved, that leſs than 1000 merks would not produce the deſired effect; towards which ſum the ſaid archbiſhop preſented the king 300 merks. The money being now prepared, the management of the deſign was committed to Mr Robert Turnour; who then was maſter of the robes to the king, and a perſon moſt in favour with him of any of his condition. Mr Turnour took to his aſſiſtance Mr Caxton, a citizen of good abilities, who traded much into Holland; which was a creditable pretence, as well for his going, as ſtay in the Low Countries. Mr Turnour was in diſguiſe

Printing. (his beard and hair ſhaven quite off); but Mr Caxton appeared known and public. They, having received the ſaid ſum of 1000 merks, went firſt to Amſterdam, then to Leyden, not daring to enter Harlem itſelf; for the town was very jealous, having impriſoned and apprehended divers perſons who came from other parts for the ſame purpoſe. They ſtaid till they had ſpent the whole thouſand merks in gifts and expences: ſo as the king was fain to ſend 500 merks more, Mr Turnour having written to the king that he had almoſt done his work; a bargain, as he ſaid, being ſtruck betwixt him and two Hollanders, for bringing off one of the underworkmen, whoſe name was Frederick Corſells (or rather Corſellis), who late one night ſtole from his fellows in diſguiſe into a veſſel prepared before for that purpoſe; and ſo, the wind favouring the deſign, brought him ſafe to London. It was not thought ſo prudent to ſet him on work at London: but, by the archbiſhop's means (who had been vice-chancellor and afterwards chancellor of the univerſity of Oxon) Corſellis was carried with a guard to Oxon; which guard conſtantly watched, to prevent Corſellis from any poſſible eſcape, till he had made good his promiſe in teaching them how to print. So that at Oxford printing was firſt ſet up in England, which was before there was any printing-preſs or printer in France, Spain, Italy, or Germany (except the city of Mentz), which claims ſeniority, as to printing, even of Harlem itſelf, calling her city, *Urbem Moguntinam artis typographicæ inventricem primam*; though it is known to be otherwiſe, that city gaining the art by the brother of one of the workmen of Harlem, who had learnt it at home of his brother, and after ſet up for himſelf at Mentz. This preſs at Oxon was at leaſt ten years before there was any printing in Europe, except at Harlem and Mentz, where it was but new-born. This preſs at Oxford was afterwards found inconvenient to be the ſole printing-place of England; as being too far from London and the ſea. Wherefore the king ſet up a preſs at St Alban's, and another in the city of Weſtminſter, where they printed ſeveral books of *divinity* and *phyſic: for the king* (for reaſons beſt known to himſelf and council) *permitted then no law-books to be printed*; nor did any printer exerciſe that art, but only ſuch as were the king's ſworn ſervants, *the king himſelf having the price and emolument for printing books.*—By this means the art grew ſo famous, that anno primo Richard III. c. 9. when an act of parliament was made for reſtraint of aliens for uſing any handicrafts here (except as ſervants to natives), a ſpecial proviſo was inſerted, that ſtrangers might bring in printed or written books to ſell at their pleaſure, and exerciſe the art of printing here, notwithſtanding that act: ſo that in the ſpace of 40 or 50 years, by the indulgence of Edward IV. Edward V. Richard III. Henry VII. and Henry VIII. the Engliſh proved ſo good proficients in printing, and grew ſo numerous, as to furniſh the kingdom with books; and ſo ſkilful, as to print them as well as any beyond the ſeas; as appears by the act 25 Hen. VIII. c. 15. which abrogates the ſaid proviſo for that reaſon. And it was further enacted in the ſaid ſtatute, that if any perſon bought foreign books bound, he ſhould pay 6s. 8d. *per* book. And it was further provided and enacted, that in caſe the ſaid printers or ſellers of books were unreaſonable in their prices, they ſhould be moderated by the lord chancellor, lord treaſurer, the two lords chief juſtices, or any two of them; who alſo had power to fine them 3s. 4d. for every book whoſe price ſhould be enhanced.—But when they were by charter corporated with *bookbinders*, *bookſellers*, and *founders of letters*, 3 & 4 Philip and Mary, and called *The Company of Stationers*—they kick'd againſt the power that gave them life, &c.—Queen Eliſabeth, the firſt year of her reign, grants by patent *the privilege of ſole printing all books that touch or concern the common laws of England*, to Tottel a ſervant to her majeſty, who kept it entire to his death; after him, to one Yeſt Weirt, another ſervant to her majeſty; after him, to Weight and Norton; and after them, king James grants the ſame privilege to More, one of the ſignet; which grant continues to this day, &c." Printing.

12 Whether Caxton or Corſellis was the firſt printer.

From the authority of this record, all our later writers declare Corſellis to be the firſt printer in England; Mr Anthony Wood, the learned Mr Maittaire, Palmer, and one John Bagford, an induſtrious man, who had publiſhed propoſals for an Hiſtory of Printing, (Phil. Tranſ. for April 1707). But Dr Middleton has called in queſtion the authenticity of this account, and has urged ſeveral objections to it, with the view of ſupporting Caxton's title to the precedency with reſpect to the introduction of the art into this country; of which we ſhall quote one or two, with the anſwers that have been made to them.

Objection 1.—"The ſilence of Caxton concerning a fact in which he is ſaid to be a principal actor, is a ſufficient confutation of it: for it was a conſtant cuſtom with him, in the prefaces or concluſions of his works, to give an hiſtorical account of all his labours and tranſactions, as far as they concerned the publiſhing and printing of books. And, what is ſtill ſtronger, in the continuation of the Polychronicon, compiled by himſelf, and carried down to the end of Henry the ſixth's reign, he makes no mention of the expedition in queſt of a printer: which he could not have omitted, had it been true; whilſt in the ſame book he takes notice of the invention and beginning of printing in the city of Mentz."

Anſwer.—As Caxton makes no mention in his Polychronicon of his *expedition in queſt of a printer*; ſo neither does he of his *bringing the art into England*, which it is as much a wonder he ſhould omit as the other. And as to his ſaying that *the invention of printing was at Mentz*, he means, of printing on *fuſile* ſeparate types. In this he copies, as many others have, from the *Faſciculus Temporum*; a work written in 1470, by Wernerus Rolevinch de Laer, a Carthuſian monk, a MS. copy of which was in the library of Gerard Jo. Voſſius (ſee lib. iii. *de Hiſtor. Latin.* c. 6.); and afterwards continued to the year 1474, when it was firſt printed at Cologne *typis Arnoldi ter Huernen*. It was republiſhed in 1481 by Heinricus Wirczburgh de Vach, a Cluniac monk, without mentioning the name either of the printer or of the place of publication. It is plain that Caxton had one at leaſt, or more probably both, of theſe editions before him, when he wrote his continuation of Polychronicon, as he mentions this work in his preface, and adopts the ſentiments of its editor. (See MEERMAN, vol. ii. p. 37. and his *Documenta*, N° VII. XXIV. and XXV.)

Obj. 2.—"There is a farther circumſtance in Caxton's hiſtory, that it ſeems inconſiſtent with the record; for we find him ſtill beyond ſea, about twelve years after the

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the ſuppoſed tranſactions, "learning with great charge and trouble the art of printing" (*Recule of the Hiſtories of Troye*, in the end of the 2d and 3d books); which he might have done with eaſe at home, if he had got Corſellis into his hands, as the record imports, ſo many years before: but he probably learnt it at Cologne, where he reſided in 1471, (*Recule*, &c. ibid.), and whence books had been firſt printed with date the year before."

Anſ.—Caxton tells us, in the preface to *The Hiſtory of Troye*, that he began that tranſlation March 1. 1468, at Bruges; that he proceeded on with it at Ghent; that he finiſhed it at Cologne in 1471; and printed it, probably, in that city with his own types. He was 30 years abroad, chiefly in Holland; and lived in the court of Margaret ducheſs of Burgundy, ſiſter of Edward IV. It was therefore much eaſier to print his book at Cologne, than to croſs the ſea to learn the art at Oxford. But further, there was a ſpecial occaſion for his printing it abroad. Corſellis had brought over ſo far the art of printing as he had learned it at Harlem, which was the method of printing on *wooden ſeparate* types, having the face of the letter cut upon them. But the art of *caſting* metal types being divulged in 1462 by the workmen of Mentz, Caxton thought proper to learn that advantageous branch before he returned to England. This method of caſting the types was ſuch an improvement, that they looked on it as the *original* of printing; and Caxton, as moſt others do, aſcribes that to Mentz.—Caxton was an aſſiſtant with Turnour in getting off Corſellis; but it is nowhere ſuppoſed that he came with him into England. (See MEERMAN, vol. ii. p. 34. B.)

Obj. 3.—"As the Lambeth record was *never heard of before the publication of Atkyn's book*, ſo it has never ſince been ſeen or produced by any man; though the regiſters of Canterbury have on many occaſions been diligently and particularly ſearched for it. They were examined, without doubt, very carefully by archbiſhop Parker, for the compiling his *Antiquities of the Britiſh Church*; where, in the life of Thomas Bourchier, tho' he congratulates that age on the noble and uſeful invention of printing, yet he is ſilent as to the introduction of it into England by the endeavours of that archbiſhop: nay, his giving the honour of the invention to Straſburg clearly ſhows that he knew nothing of the ſtory of Corſellis conveyed from Harlem, and that the record was not in being in his time. Palmer himſelf owns, "That it is not to be found there now; for that the late earl of Pembroke aſſured him, that he had employed a perſon for ſome time to ſearch for it, but in vain:" (*Hiſt. of Printing*, p. 314.) On theſe grounds we may pronounce the record to be a forgery; though all the writers above-mentioned take pains to ſupport its credit, and call it an *authentic piece*.

Atkyns, who by his manner of writing ſeems to have been *a bold and vain man*, might poſſibly be *the inventor:* for he had an intereſt in impoſing it upon the world, in order to confirm the argument of his book, that *printing was of the prerogative royal*; in oppoſition to the *company of ſtationers*, with whom he was engaged in an expenſive ſuit of law, in defence of the *king's patents*, under which he claimed *ſome excluſive powers of printing*. For he tells us, p. 3. 'That, upon conſidering the thing, he could not but think that a public perſon, more eminent than a mercer, and a public purſe, muſt needs be concerned in ſo public a good: and the more he conſidered, the more inquiſitive he was to find out the truth. So that he had formed his hypotheſis before he had found his record; which he publiſhed, he ſays, as a friend to truth; not to ſuffer one man to be intitled to the worthy atchievements of another; and as a friend to himſelf, not to loſe one of his beſt arguments of entitling the king to this art.' But, if Atkyns was not himſelf the contriver, he was impoſed upon at leaſt by ſome more crafty man; who imagined that his intereſt in the cauſe, and the warmth that he ſhowed in proſecuting it, would induce him to ſwallow for genuine whatever was offered of the kind."

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Anſ.—On the other hand, is it likely that Mr Atkyns would dare to *forge* a record, to be laid before the king and council, and which his adverſaries, with whom he was at law, could diſprove?—(2.) He ſays he received this hiſtory from a perſon of honour, who was ſome time keeper of the Lambeth library. It was eaſy to have confuted this evidence, if it was falſe, when he publiſhed it, April 25. 1664.—(3.) John Bagford (who was born in England 1651, and might know Mr Atkyns, who died in 1677), in his Hiſtory of Printing at Oxford, blames thoſe who doubted of the authenticity of the Lambeth MS.; and tells us that he knew Sir John Birkenhead had an authentic copy of it, when in 1665 [which Bagford by ſome miſtake calls 1664, and is followed in it by Meerman] he was appointed by the houſe of commons to draw up a bill relating to the exerciſe of that art. This is confirmed by the Journals of that houſe, Friday Oct. 27. 1665. vol. VIII. p. 622. where it is ordered, that this Sir John Birkenhead ſhould carry the bill on that head to the houſe of lords for their conſent.—The act was agreed to in the upper houſe on Tueſday Oct. 31. and received the royal aſſent on the ſame day; immediately after which the parliament was prorogued. See *Journals of the Houſe of Lords*, Vol. XI. p. 700.—It is probable, then, that after Mr Atkyns had publiſhed his book in April 1664, the parliament thought proper, the next year, to inquire into *the right of the king's prerogative*; and that Sir John Birkenhead took care to inſpect the original, then in the cuſtody of archbiſhop Sheldon: and, finding it not ſufficient to prove what Mr Atkyns had cited it for, made no report of the MS. to the houſe; but only moved, that the former law ſhould be renewed. The MS. was probably never returned to the proper keeper of it; but was afterwards burnt in the fire of London, Sept. 13. 1666.—(4.) That printing was practiſed at Oxford, was a prevailing opinion long before Atkyns. Bryan Twyne, in his *Apologia pro Antiquitate Academiæ Oxonienſis*, publiſhed 1608, tells us, it is ſo delivered down in *ancient writings*; having heard, probably, of this Lambeth MS. And king Charles I. in his letters patent to the Univerſity of Oxford, March 5. in the eleventh of his reign, 1635, mentions printing as brought to *Oxford* from abroad. As to what is objected, "that it is not likely that the preſs ſhould undergo a ten or eleven years ſleep, viz. from 1468 to 1479," it is probably urged without foundation. Corſellis might print ſeveral books without date or name of the place, as Ulric Zell did at Cologne, from 1467 to 1473, and from that time to 1494. Corſellis's name, it may be ſaid, appears not in any of his publications; but neither does

Printing. that of Joannes Peterſhemius. [See MEERMAN, vol. I. p. 34.; vol. II. p. 21—27, &c.

Further, the famous Shakeſpeare, who was born in 1564, and died 1616, in the Second Part of Henry VI. act iv. ſc. 7. introduces the rebel John Cade, thus upbraiding Lord Treaſurer Say: "Thou haſt moſt traiterouſly corrupted the youth of the realm, in creating a grammar-ſchool: and whereas, before, our forefathers had no other book but the ſcore and the tally, thou haſt cauſed *Printing* to be uſed; and, contrary to the king, his crown, and dignity, thou haſt built a paper-mill."—Whence now had Shakeſpeare this accuſation againſt lord Say? We are told in the Poetical Regiſter, vol. II. p. 231. ed. Lond. 1724, that it was from Fabian, Pol. Vergel, Hall, Hollingſhed, Grafton, Stow, Speed, &c. But not one of theſe aſcribes printing to the reign of Henry VI. On the contrary, Stow, in his Annals, printed at London 1560, p. 686, gives it expreſsly to William Caxton, 1471. "The noble ſcience of printing was about this time found out in Germany at Magunce, by one John Guthumburgus a knight. One Conradus an Almaine brought it into Rome: William Caxton of London mercer, brought it into England about the year 1471, and firſt practiſed the ſame in the Abbie of St Peter at Weſtminſter; after which time it was likewiſe practiſed in the Abbies of St Auguſtine at Canterburie, Saint Albons, and other monaſteries of England." What then ſhall we ſay, that the above is an anachroniſm arbitrarily put into the mouth of an ignorant fellow out of Shakeſpeare's head? We might believe ſo, but that we have the record of Mr Atkyns confirming the ſame in king Charles II.'s time. Shall we ſay, that Mr Atkyns borrowed the ſtory from Shakeſpeare, and publiſhed it with ſome improvements of money laid out by Henry VI. from whence it might be received by Charles II. as a prerogative of the crown? But this is improbable, ſince Shakeſpeare makes Lord Treaſurer Say the inſtrument of importing it, of whom Mr Atkyns mentions not a word. Another difference there will ſtill be between Shakeſpeare and the Lambeth MS.; the poet placing it before 1449, in which year Lord Say was beheaded; the MS. between 1454 and 1459, when Bourchier was archbiſhop. We muſt ſay, then, that lord Say firſt laid the ſcheme, and ſent ſome one to Harlem, though without ſucceſs; but after ſome years it was attempted happily by Bourchier. And we muſt conclude, that as the generality of writers have overlooked the invention of printing at Harlem with *wooden* types, and have aſcribed it to Mentz where *metal* types were firſt made uſe of; ſo in England they have paſſed by Corſellis (or the firſt *Oxford Printer*, whoever he was, who printed with *wooden* types at Oxford), and only mentioned Caxton as the original artiſt who printed with *metal* types at Weſtminſter. [See MEERMAN, vol. ii. 7, 8.] It is ſtrange, that the learned commentators on our great dramatic poet, who are ſo minutely particular upon leſs important occaſions, ſhould every one of them, Dr Johnſon excepted, paſs by this curious paſſage, leaving it entirely unnoticed. And how has Dr Johnſon trifled, by ſlightly remarking, "that Shakeſpeare is a little *too early* with this accuſation!"—The great critic had undertaken to decipher obſolete words, and inveſtigate unintelligible phraſes; but never, perhaps, beſtowed a thought on Caxton or Corſellis, on Mr Atkyns or the authenticity of the Lambeth Record. Printing.

But, independent of the record altogether, the book ſtands firm as a monument of the exerciſe of printing in Oxford ſix years older than any book of Caxton's with a date. In order to get clear of this ſtrong fact Dr Middleton,

1. Suppoſes the date in queſtion to have been falſified originally by the printer either by deſign or miſtake; and an X to have been dropped or omitted in the age of its impreſſion. Examples of this kind, he ſays, are common in the hiſtory of printing. And, "whilſt I am now writing, an unexpected inſtance is fallen into my hands, to the ſupport of my opinion; an *Inauguration Speech of the Woodwardian Profeſſor, Mr Maſon*, juſt freſh from the preſs, with its date given 10 years earlier than it ſhould have been, by the omiſſion of an x, viz. MDCCXXIV; and the very blunder exemplified in the laſt piece printed at Cambridge, which I ſuppoſe to have happened in the firſt from Oxford."——To this it has been very properly anſwered, That we ſhould not pretend to ſet aſide the authority of *a plain date*, without very ſtrong and cogent reaſons; and what the Doctor has in this caſe advanced will not appear, on examination, to carry that weight with it that he ſeems to imagine. There may be, and have been, miſtakes and forgeries in the date both of books and of records too; but this is never allowed as a reaſon for ſuſpecting ſuch as bear no mark of either. We cannot from a blunder in the laſt book printed at Cambridge, infer a like blunder in the firſt book printed at Oxford. Beſides, the *type* uſed in this our Oxford edition ſeems to be no ſmall proof of its antiquity. It is the German letter, and very nearly the ſame with that uſed by Fuſt [who has been ſuppoſed to be] the firſt printer; whereas Caxton and Rood uſe a quite different letter, ſomething between this German and our old Engliſh letter, which was ſoon after introduced by De Worde and Bynſon.

2. "For the probability of his opinion (he ſays), the book itſelf affords ſufficient proof: for, not to inſiſt on what is leſs material, the *neatneſs of the letter, and regularity of the page*, &c. above thoſe of Caxton, it has one mark, that ſeems to have carried the matter beyond probable, and to make it even certain, viz. *the uſe of ſignatures*, or letters of the alphabet placed at the bottom of the page, to ſhow the ſequel of the pages and leaves of each book; an improvement contrived for the direction of the bookbinders; which yet was not practiſed or invented at the time when this book is ſuppoſed to be printed; for we find no ſignatures in the books of Fauſt or Schoeffer at Mentz, nor in the improved or beautiful impreſſions of John de Spira and Jenſon at Venice, till ſeveral years later. We have a book in our library, that ſeems to fix the very time of their invention, at leaſt in Venice; the place where the art itſelf received the greateſt improvements: *Baldi lectura ſuper Codic. &c.* printed by *John de Colonia* and *Jo. Manthem de Gherretzem, anno* MCCCCLXXIIII. It is a large and fair volume in folio, *without ſignatures*, till about the middle of the book, in which they are firſt introduced, and ſo continued forward: which makes it probable, that the firſt thought of them was ſuggeſted during the impreſſion; for we have likewiſe *Lectura Bartholi ſuper Codic.* &c. in two noble and beautiful volumes in folio, printed Printing.

the

Printing. the year before at the same place, by Vindelin de Spira, without them: yet from this time forward they are generally found in all the works of the Venetian printers, and from them propagated to the other printers of Europe. They were used at (1) Cologne, in 1475; at Paris, 1476; by Caxton, not before 1480: but if the discovery had been brought into England, and practised at Oxford 12 years before, it is not probable that he would have printed so long at Westminster without them. Mr Palmer indeed tells us, p. 54, 180, that Anthony Zarot was esteemed the inventor of signatures; and that they are found in a Terence printed by him at Milan in the year 1470, in which he first printed. I have not seen that Terence; and can only say, that I have observed the want of them in some later works of this, as well as of other excellent printers of the same place. But, allowing them to be in the Terence, and Zarot the inventor, it confutes the date of our Oxford book as effectually as if they were of later origin at Venice; as I had reason to imagine, from the testimony of all the books that I have hitherto met with."—As to these proofs, first, the neatness of the letter, and the regularity of the page, prove, if any thing, the very reverse of what the Doctor asserts. The art of printing was almost in its infancy brought to perfection; but afterwards debased by later printers, who consulted rather the cheapness than the neatness of their work. Our learned dissertator cannot be unacquainted with the labours of Fust and Jenson. He must know, that though other printers may have printed more correctly, yet scarce any excel them, either in the neatness of the letter, or the regularity of the page. The same may be observed in our English printers. Caxton and Rood were indifferently good printers; De Worde and Pynson were worse; and those that follow them most abominable. This our *anonymous Oxford printer* excels them all; and for this very reason we should judge him to be the most ancient of all. Our dissertator lays great stress on the use of signatures. But no certain conclusion can be drawn either from the use or non-use of these lesser improvements of printing. They have in different places come in use at different times, and have not been continued regularly even at the same places. If Anthony Zarot used them at Milan in 1470, it is certain later printers there did not follow his example; and the like might happen also in England. But, what is more full to our purpose, we have in the Bodleian library an Æsop's Fables printed by Caxton. This is, it is believed, the first book which has *the leaves numbered*. But yet this improvement, though more useful than that of the signatures, was disused both by Caxton himself and other later printers in England. It is therefore not at all surprising (if true) that the signatures, though invented by our Oxford printer, might not immediately come into general use. And consequently, this particular carries with it no such certain or effectual confutation as our dissertator boasts of. Printing.

3. What the Doctor thinks farther confirms his opinion is, "That, from the time of the pretended date of this book, *anno* 1468, we have no other fruit or production from the press at Oxford for 11 years next following; and it cannot be imagined that a press, established with so much pains and expence, could be suffered to be so long idle and useless."—To this it may be answered, in the words of Oxonides, 1st, That his books may have been lost. Our first printers, in those days of ignorance, met with but small encouragement; they printed but few books, and but few copies of those books. In after-times, when the same books were reprinted more correctly, those first editions, which were not as yet become curiosities, were put to common uses. This is the reason that we have so few remains of our first printers. We have only four books of Theodoric Rood, who seems by his own verses to have been a very celebrated printer. Of John Lettou-William de Machlinia, and the schoolmaster of St Alban's, we have scarce any remains. If this be considered, it will not appear *impossible* that our printer should have followed his business from 1468 to 1479, and yet time have destroyed his intermediate works. But, 2dly, We may account still another way for this distance of time, without altering the date. The Civil Wars broke out in 1469: this might probably oblige our Oxford printer to shut up his press; and both himself and his readers be otherwise engaged. If this were the case, he might not return to his work again till 1479; and the next year, not meeting with that encouragement he deserved, he might remove to some other country with his types.

Dr Middleton concludes with apologizing for his "spending so much pains on an argument so inconsiderable, to which he was led by his zeal to do a piece of justice to the memory of our worthy countryman William Caxton; nor suffer him to be robbed of the glory, so clearly due to him, of having *first imported into this kingdom* an art of great use and benefit to mankind: a kind of merit that, in the sense of all nations, gives the best title to true praise, and the best claim to be commemorated with honour to posterity."

13 The real claims of Caxton and Corsellis respectively.

The fact, however, against which he contends, but which it seems impossible to overturn, does by no means derogate from the honour of Caxton, who, as has been shown, was the first person in England that practised the art of printing with *fusile types*, and consequently the first who brought it to perfection; whereas Corsellis printed with *separate cut types in wood*, being the only method which

(1) Dr Middleton is mistaken in the time and place of the invention of signatures. They are to be found even in very ancient MSS. which the earliest printers very studiously imitated; and they were even used in some editions from the office of Lawrence Coster (whence Corsellis came), which consisted of wooden cuts, as in *Figuræ typicæ et antitypicæ Novi Testamenti*; and in some editions with metal types, as in *Gasp. Pergomensis epistolæ*, published at Paris, without a date, but printed A. D. 1470, (Maittaire*, Annal. vol. i. p. 25.); and in *Mammetrectus*, printed by Helias de Llouffen, at Bern in Switzerland, 1470; and in *De Tondeli visione*, at Antwerp, 1472. Venice, therefore, was not the place where they were first introduced.—They began to be used in *Baldus*, it seems, when the book was half finished. The printer of that book might not know, or did not think, of the use of them before. See *Meerman*, vol. ii. p. 18.; and *Phil. Trans.* vol xxiii. n° 208. p. 1509.

* See *Maittaire*.

Printing.

which he had learned at Harlem. Into this detail, therefore, we have been led, not ſo much by the importance of the queſtion, as on account of ſeveral anecdotes connected with it, which ſeemed equally calculated to ſatisfy curioſity and afford entertainment.

Caxton had been bred very reputably in the way of trade, and ſerved an apprenticeſhip to one Robert Large a mercer; who, after having been ſheriff and lord mayor of London, died in the year 1441, and left by will, as may be ſeen in the prerogative-office, XXIIII merks to his apprentice William Caxton: a conſiderable legacy in thoſe days, and an early teſtimonial of his good character and integrity.

From the time of his maſter's death, he ſpent the following thirty years beyond ſea in the buſineſs of merchandiſe: where, in the year 1464, we find him employed by Edward IV. in a public and honourable negociation, jointly with one Richard Whitehill, Eſq; to tranſact and conclude a treaty of commerce between the king and his brother-in-law the duke of Burgundy, to whom Flanders belonged. The commiſſion ſtyles them, *ambaſſiatores, procuratores, nuncios, & deputatos ſpeciales*; and gives to both or either of them full powers to treat, &c.

Whoever turns over his printed works, muſt contract a reſpect for him, and be convinced that he preſerved the ſame character through life, of an honeſt, modeſt, man; greatly induſtrious to do good to his country, to the beſt of his abilities, by ſpreading among the people ſuch books as he thought uſeful to religion and good manners, which were chiefly tranſlated from the French. The novelty and uſefulneſs of his art recommended him to the ſpecial notice and favour of the great; under whoſe protection, and at whoſe expence, the greateſt part of his works were publiſhed. Some of them are addreſſed to king Edward IV. his brother the duke of Clarence, and their ſiſter the ducheſs of Burgundy; in whoſe ſervice and pay he lived many years before he began to print, as he often acknowledges with great gratitude. He printed likewiſe for the uſe, and by the expreſs order, of Henry VII. his ſon prince Arthur, and many of the principal nobility and gentry of that age.

It has been generally aſſerted and believed, that all his books were printed in the abbey of Weſtminſter; yet we have no aſſurance of it from himſelf, nor any mention of the place before the year 1477: ſo that he had been printing ſeveral years without telling us where.

There is no clear account left of Caxton's age: but he was certainly very old, and probably above fourſcore, at the time of his death. In the year 1471 he complained of the infirmities of age creeping upon him, and feebling his body: yet he lived 23 years after, and purſued his buſineſs, with extraordinary diligence, in the abbey of Weſtminſter, till the year 1494, in which he died; not in the year following, as all who write of him affirm. This appears from ſome verſes at the end of a book, called "Hilton's Scale of Perfection," printed in the ſame year:

Infynite laud with thankynges many folde
I yield to God me ſocouryng with his graee
This boke to finyſhe which that ye beholde
Scale of Perfection calde in every place
Whereof th' auctor Walter Hilton was
And Wynkyn de Worde this hath ſett in print
In William Caxſtons hows ſo fyll the caſe,
God reſt his ſoule. In joy ther mot it ſtynt.
Impreſſus anno ſalutis MCCCCLXXXXiiii.

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Though he had printed for the uſe of Edward IV. and Henry VII. yet there appears no ground for the notion which Palmer takes up, that the firſt printers, and particularly Caxton, were ſworn ſervants and printers to the crown; for Caxton, as far as can be obſerved, gives not the leaſt hint of any ſuch character or title; though it ſeems to have been inſtituted not long after his death; for of his two principal workmen, Richard Pynſon and Wynkyn de Worde, the one was made printer to the king, the other to the king's mother the Lady Margaret. Pynſon gives himſelf the firſt title, in *The imitation of the Life of Chriſt*; printed by him at the commandment of the Lady Margaret, who had tranſlated the fourth book of it from the French, in the year 1504: and Wynkyn de Worde aſſumes the ſecond, in *The ſeven Penitential Pſalms*, expounded by Biſhop Fiſher, and printed in the year 1509. But there is the title of a book given by Palmer, that ſeems to contradict what is here ſaid of Pynſon: viz. *Pſalterium ex mandato victorioſiſſimi Angliæ Regis Henrici Septimi, per Gulielmum Faque, impreſſorem regium*, anno MDIIII; which being the only work that has ever been found of this printer, makes it probable that he died in the very year of its impreſſion, and was ſucceeded immediately by Richard Pynſon. No book hath yet been diſcovered printed in Scotland in this period, though the Engliſh printers were able to export ſome of their works to other countries. See Henry's *Hiſtory of Great Britain*, vol. v. p. 471.

14 Different characters when firſt uſed in printing.

Before 1465, the uniform character was the old *Gothic* or *German*; whence our *Black* was afterwards formed. But in that year an edition of Lactantius was printed in a kind of Semi-Gothic, of great elegance, and approaching nearly to the preſent *Roman* type; which laſt was firſt uſed at Rome in 1467, and ſoon after brought to great perfection in Italy, particularly by Jenſon.

Towards the end of the 5th century, Aldus invented the *Italic* character which is now in uſe, called, from his name, *Aldine* or *curſivus*. This ſort of letter he contrived, to prevent the great number of abbreviations that were then in uſe.

15 Of the firſt Greek printing.

The firſt eſſays in Greek that can be diſcovered are a few ſentences which occur in the edition of Tully's *Offices*, 1465, at Mentz; but theſe were miſerably incorrect and barbarous, if we may judge from the ſpecimens Mr Maittaire has given us, of which the following is one:

Οτιcαταακαρτμακατα καιτατυτοκα.

In the ſame year, 1465, was publiſhed an edition of Lactantius's *Inſtitutes*, printed *in monaſterio Sublacenſi*, in the kingdom of Naples, in which the quotations from the Greek authors are printed in a very neat Greek letter. They ſeem to have had but *a very ſmall quantity* of Greek types in the monaſtery; for, in the firſt part of the work, whenever a long ſentence occurred, a blank was left, that it might be written in with a pen: after the middle of the work, however, all the Greek that occurs is printed.

Printing. The first printers who settled at Rome were Conrad Sweynheim and Arnold Pannartz, who introduced the present *Roman* type, in 1466, in Cicero's *Epistolæ Familiares:* in 1469 they printed a beautiful edition of *Aulus Gellius*, with the Greek quotations in a fair character, without accents or spirits, and with very few abbreviations.

The first whole book that is yet known is the Greek Grammar of Constantine Lascaris, in quarto, revised by Demetrius Cretensis, and printed by Dionysius Palavisinus, at Milan, 1476. In 1481, the Greek *Psalter* was printed here, with a Latin translation, in folio; as was Æsop's Fables in quarto.

Venice soon followed the example of Milan; and in 1486 were published in that city the *Greek Psalter* and the *Batrathomyomachia*, the former by Alexander, and the latter by Laonicus, both natives of Crete. They were printed in a very uncommon character; the latter of them with *accents* and *spirits*, and also with *scholia*.

In 1488, however, all former publications in this language were eclipsed by a fine edition of *Homer's Works* at Florence, in folio, printed by Demetrius, a native of Crete. Thus printing (says Mr Maittaire, p. 185.) seems to have attained its ακμη of perfection, after having exhibited most beautiful specimens of Latin, Greek, and Hebrew.

In 1493, a fine edition of *Isocrates* was printed at Milan, in folio, by Henry German and Sebastian ex Pantremulo.

All the above works are prior in time to those of Aldus, who has been erroneously supposed to be the *first* Greek printer: the beauty, however, correctness, and number of his editions, place him in a much higher rank than his predecessors; and his characters in general were more elegant than any before used. He was born in 1445, and died in 1515.

Though the noble Greek books of Aldus had raised an universal desire of reviving that tongue, the French were backward in introducing it. The only pieces printed by them were some quotations, so wretchedly performed, that they were rather to be guessed at than read; in a character very rude and uncouth, and without accents. But Francis Tissard introduced the study of this language at Paris, by his Βιβλος η γνωμαγυρικη, in 1507; and that branch of printing was afterwards successfully practised by Henry, Robert, and Henry Stephens. See the article STEPHENS.

The earliest edition of the *whole Bible* was, strictly speaking, the Complutensian Polyglott of Cardinal Ximenes; but as that edition, though finished in 1517, was not published till 1522, the *Venetian* Septuagint of 1518 may properly be called the first edition of the *whole* Greek Bible; Erasmus having published the New Testament *only* at Basil in 1516.

16 Of the first Hebrew printing.

A very satisfactory account of Hebrew printing is thus given by Dr Kennicott in his *Annual Accounts of the Collation of Hebrew MSS.* p. 112. "The method which seems to have been originally observed in printing the Hebrew Bible was just what might have been expected: 1. The Pentateuch in 1482. 2. The Prior Prophets, in 1484. 3. The Posterior Prophets, in 1486. 4. The Hagiographa, in 1487. And, after the four great parts had been thus printed separately (each with a comment), the whole text (without a comment) was printed in one volume in 1488; and the text continue to be printed, as in these first editions, so in several others for 20 or 30 years, without marginal *Keri* or *Masora*, and with greater arguments to the more ancient MSS. till about the year 1520 some of the Jews adopted later MSS. and the *Masora;* which absurd preference has obtained ever since."

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Thus much for the ancient editions given by Jews.

In 1642 a Hebrew Bible was printed at Mantua under the care of the most learned Jews in Italy. This Bible had not been heard of among the Christians in this country, nor perhaps in any other; though the nature of it is very extraordinary. The text indeed is nearly the same with that in other modern editions; but at the bottom of each page are various readings, amounting in the whole to above 2000, and many of them of great consequence, collected from manuscripts, printed editions, copies of the Talmud, and the works of the most renowned Rabbies. And in one of the notes is this remark:—"That in several passages of the Hebrew Bible the differences are so many and so great, that they know not which to fix upon as the true readings."

We cannot quit this subject without observing, on Dr Kennicott's authority, that as the first printed Bibles are more correct than the latter ones; so the variations between the first edition, printed in 1488, and the edition of Vander Hooght, in 1705, at Amsterdam, in 2 vols 8vo, amount, upon the whole, to above 1200! See further *Bowyer and Nichols*, p. 112—117.

17 Anecdotes of early printing.

When the art of printing was first discovered, they only made use of one side of a page: they had not yet found out the expedient of impressing the other. When their editions were intended to be curious, they omitted to print the first letter of a chapter, for which they left a blank space, that it might be painted or illuminated at the option of the purchaser. Several ancient volumes of these early times have been found, where these letters are wanting, as they neglected to have them painted.

When the art of printing was first established, it was the glory of the learned to be correctors of the press to the eminent printers. Physicians, lawyers, and bishops themselves, occupied this department. The printers then added frequently to their names those of the correctors of the press; and editions were then valued acccording to the abilities of the corrector.

In the productions of early printing may be distinguished the various splendid editions they made of *Primers* or *Prayer-books*. They were embellished with cuts finished in a most elegant taste: many of them were ludicrous, and several were obscene. In one of them an angel is represented crowning the Virgin Mary, and God the Father himself assisting at the ceremony. We have seen in a book of natural history the Supreme Being represented as *reading* on the seventh day, when he rested from all his works. Sometimes St Michael is seen overcoming Satan; and sometimes St Anthony appears attacked by various devils of most hideous forms. The *Prymer of Salisbury*, 1533, is full of cuts: at the bottom of the title page there is the following remarkable prayer:

God be in my Bede,
And in my Understandynge.
God be in my Eyen,
And in my Lokynge.

Printing.

God be in my Mouthe,
And in my Spekynge.
God be in my Herte,
And in my thinkinge.
God be at myn ende,
And at my departynge.

18 Method of printing.

The workmen employed in the art of printing are of two kinds: compoſitors, who range and diſpoſe the letters into words, lines, pages, &c. according to the copy delivered them by the author; and preſſmen, who apply ink upon the ſame, and take off the impreſſion. The types being caſt, the compoſitor diſtributes each kind by itſelf among the diviſions of two wooden frames, an upper and an under one, called *caſes*; each of which is divided into little cells or boxes. Thoſe of the upper caſe are in number 98: theſe are all of the ſame ſize; and in them are diſpoſed the capitals, ſmall capitals, accented letters, figures, &c. the capitals being placed in alphabetical order. In the cells of the lower caſe, which are 54, are placed the ſmall letters, with the points, ſpaces, &c. The boxes are here of different ſizes, the largeſt being for the letters moſt uſed; and theſe boxes are not in alphabetical order, but the cells which contain the letter oſteneſt wanted are neareſt the compoſitor's hand. Each caſe is placed a little aſlope, that the compoſitor may the more eaſily reach the upper boxes. The inſtrument in which the letters Plate CCCCXV. are ſet is called a *compoſing-ſtick* (*n* 1.), which conſiſts of a long and narrow plate of braſs or iron, &c. on the right ſide of which ariſes a ledge, which runs the whole length of the plate, and ſerves to ſuſtain the letters, the ſides of which are to reſt againſt it; along this ledge is a row of holes, which ſerve for introducing the ſcrew *a*, in order to lengthen or ſhorten the extent of the line, by moving the ſliders *b c* farther from or nearer to the ſhorter ledge at the end *d*. Where marginal notes are required in a work, the two ſliding pieces *b c* are opened to a proper diſtance from each other in ſuch a manner as that while the diſtance between *d c* forms the length of the line in the text, the diſtance between the two ſliding-pieces forms the length of the lines for the notes on the ſide of the page. Before the compoſitor proceeds to compoſe, he puts a rule or thin ſlip of braſs-plate, cut to the length of the line, and of the ſame height as the letter, in the compoſing-ſtick, againſt the ledge, for the letter to bear againſt. Things thus prepared, the compoſitor having the copy lying before him, and his ſtick in his left-hand, his thumb being over the ſlider *c*; with the right he takes up the letters, ſpaces, &c. one by one, and places them againſt the rule, while he ſupports them with his left thumb by preſſing them to the end of the ſlider *c*, the other hand being conſtantly employed in ſetting in other letters: the whole being performed with a degree of expedition and addreſs not eaſy to be imagined.

A little being thus compoſed, if it end with a word or ſyllable, and exactly fill the meaſure, there needs no further care; otherwiſe, more ſpaces are to be put in, or elſe the diſtances leſſened, between the ſeveral words, in order to make the meaſure quite full, ſo that every line may end even. The ſpaces here uſed are pieces of metal exactly ſhaped like the ſhanks of the letters: they are of various thickneſſes, and ſerve to ſupport the letters, and to preſerve a proper diſtance between the words; but not reaching ſo high as the letters, they make no impreſſion when the work is printed. The firſt line being thus finiſhed, the compoſitor proceeds to the next; in order to which he moves the braſs-rule from behind the former, and places it before it, and thus compoſes another line againſt it after the ſame manner as before; going on thus till his ſtick is full, when he empties all the lines contained in it into the gally. Printing.

The compoſitor then fills and empties his compoſing-ſtick as before, till a complete page be formed; when he ties it up with a cord or pack-thread; and ſetting it by, proceeds to the next, till the number of pages to be contained in a ſheet is completed; which done, he carries them to the *impoſing-ſtone*, there to be ranged in order, and faſtened together in a frame called a *chaſe*; and this is termed *impoſing*. The chaſe is a rectangular iron frame, of different dimenſions according to the ſize of the paper to be printed, having two croſs-pieces of the ſame metal, called a *long* and *ſhort croſs*, mortiſed at each end ſo as to be taken out occaſionally. By the different ſituations of theſe croſſes the chaſe is fitted for different volumes: for quartos and octavos, one traverſes the middle lengthwiſe, the other broadwiſe, ſo as to interſect each other in the centre: for twelves and twenty-fours, the ſhort croſs is ſhifted nearer to one end of the chaſe; for folios, the long croſs is left entirely out, and the ſhort one left in the middle; and for broad-ſides, both croſſes are ſet aſide. To dreſs the chaſe, or range and fix the pages therein, the compoſitor makes uſe of a ſet of furniture, conſiſting of ſlips of wood of different dimenſions, and about half an inch high, that they may be lower than the letters: ſome of theſe are placed at the top of the pages, and called *head-ſticks*; others between them, to form the inner margin; others on the ſides of the croſſes, to form the outer margin, where the paper is to be doubled; and others in the form of wedges to the ſides and bottoms of the pages. Thus all the pages being placed at their proper diſtances, and ſecured from being injured by the chaſe and furniture placed about them, they are all untied, and faſtened together by driving ſmall pieces of wood called *quoins*, cut in the wedge-form, up between the ſlanting ſide of the foot and the ſide ſticks and the chaſe, by means of a piece of hard wood and a mallet; and all being thus bound faſt together, ſo that none of the letters will fall out, it is ready to be committed to the preſſmen. In this condition the work is called a *form*; and as there are two of theſe forms required for every ſheet, when both ſides are to be printed, it is neceſſary the diſtances between the pages in each form ſhould be placed with ſuch exactneſs, that the impreſſion of the pages in one form ſhall fall exactly on the back of the pages of the other, which is called *regiſter*.

As it is impoſſible but that there muſt be ſome miſtakes in the work, either through the overſight of the compoſitor, or by the caſual tranſpoſition of letters in the caſes; a ſheet is printed off, which is called a *proof*, and given to the corrector; who reading it over, and rectifying it by the copy, making the alterations in the margin, it is delivered back to the compoſitor to be corrected.

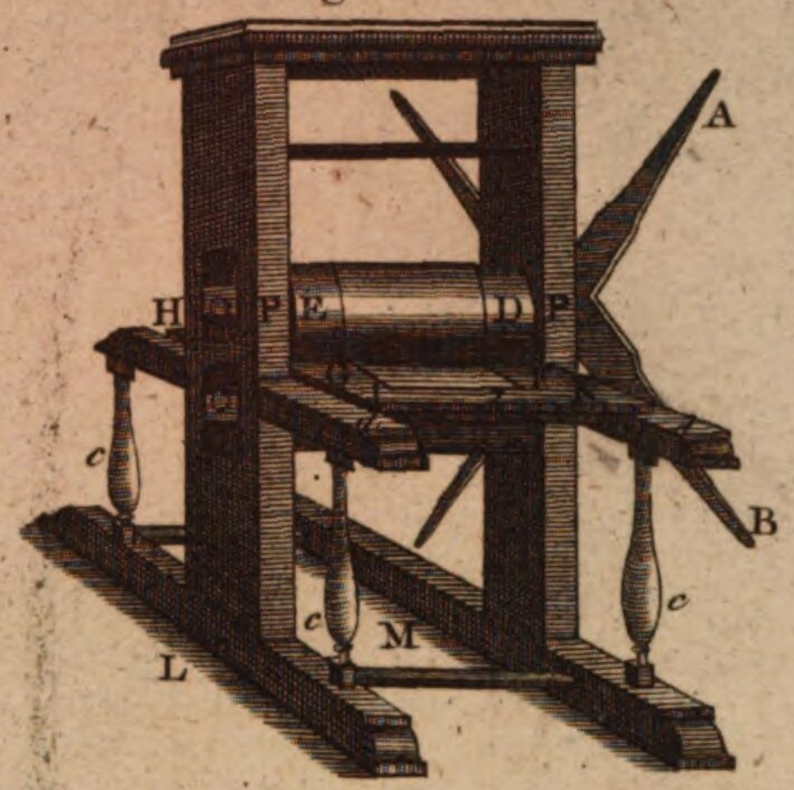
The compoſitor then unlocking the form upon the correcting-ſtone, by looſening the *quoins* or wedges which bound the letters together, rectifies the miſtakes by

Plate CCCCXV.

Printing PRESS.

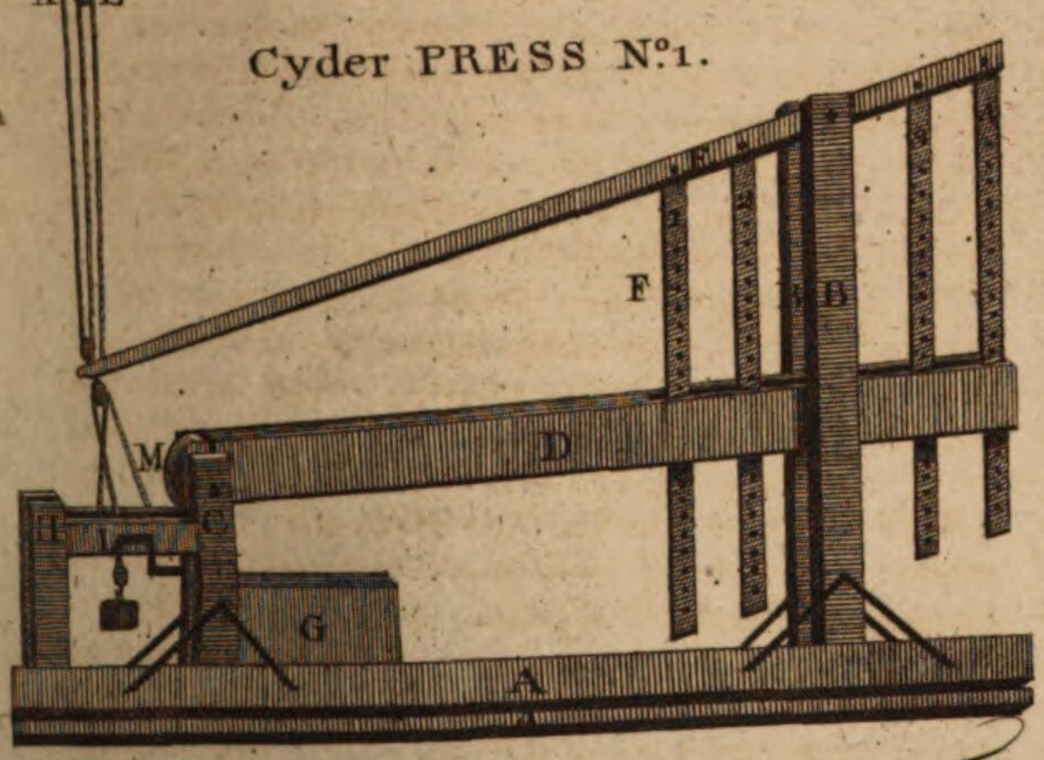
Composing Stick.

Rolling PRESS.



K L

Cyder PRESS N°1.



Cyder PRESS N.° 2

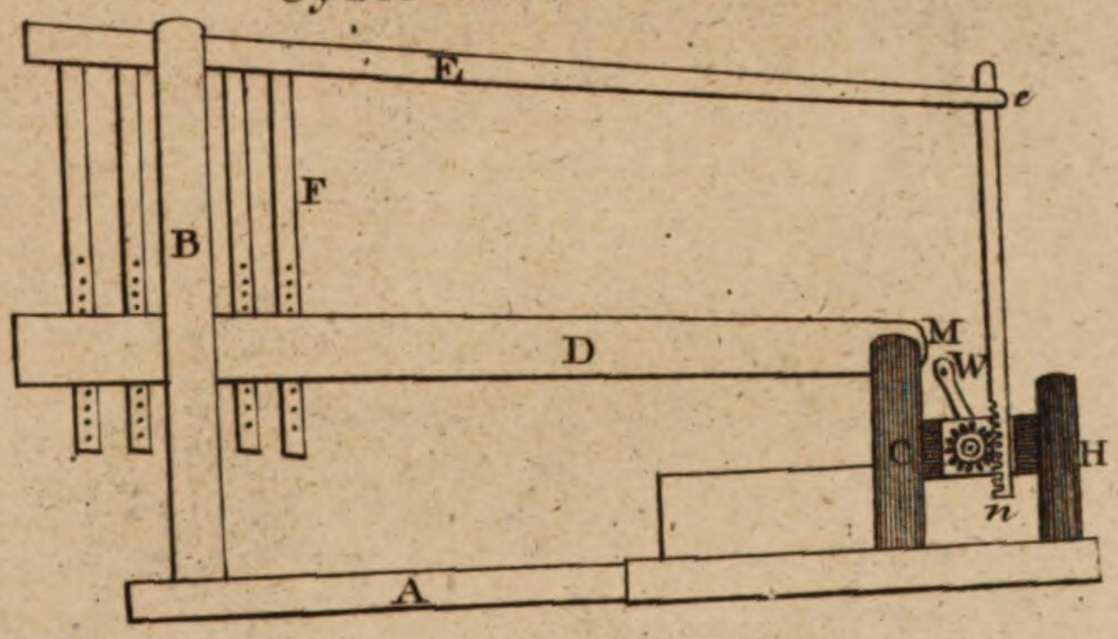
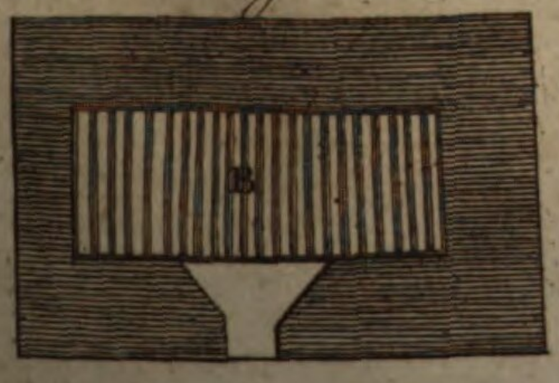


Fig. 4. Potash-kiln.

Fig. 1.

Fig. 2.



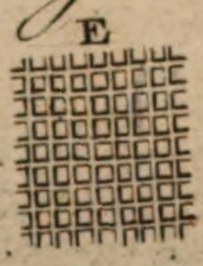


Fig. 3.

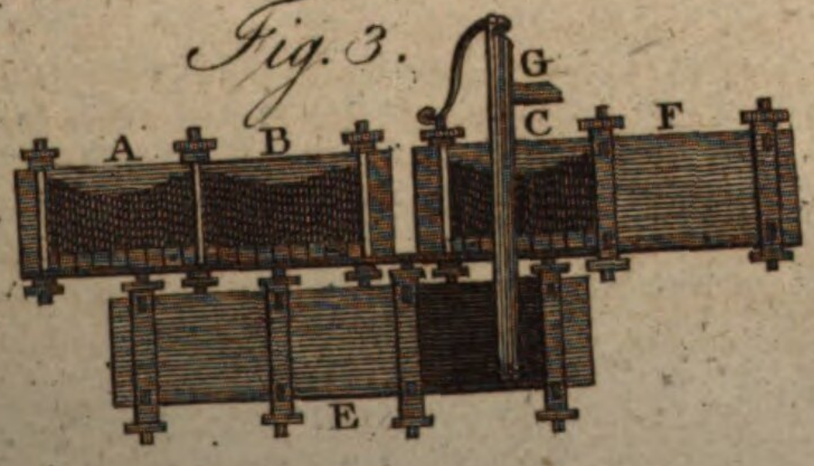
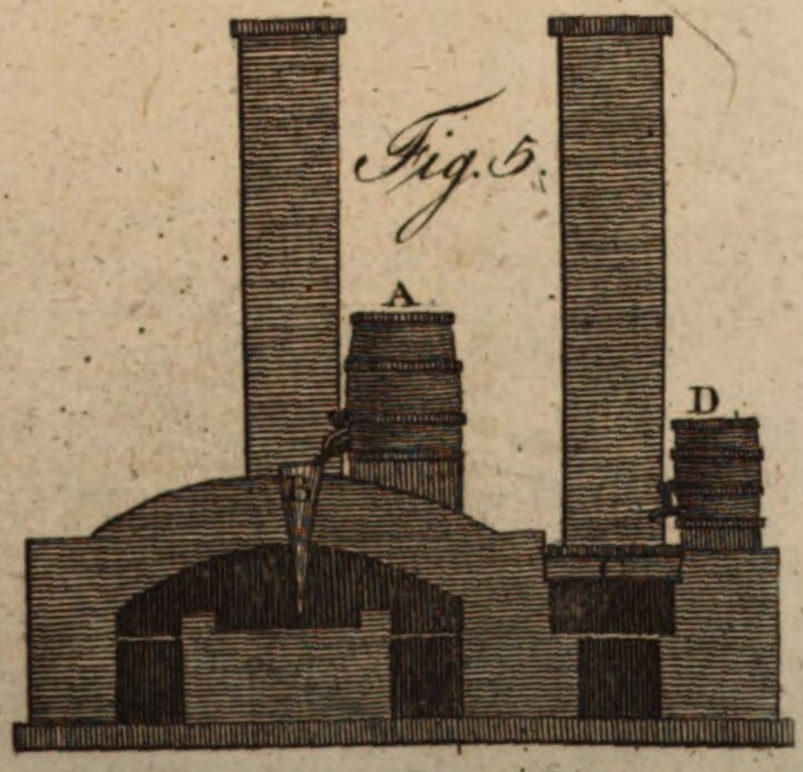


Fig. 5.



A. Bell Print. Wal. Sculptor fecit.

Printing. by picking out the faulty or wrong letters with a ſlender ſharp-pointed ſteel-bodkin, and putting others into their places. After this another proof is made, ſent to to the author, and corrected as before; and laſtly, there is another proof called a *reviſe*, which is made in order to ſee whether all the miſtakes marked in the laſt proof are corrected.

The preſſman's buſineſs is to work off the forms thus prepared and corrected by the compoſitor; in doing which there are four things required, paper, ink, balls, and a preſs. To prepare the paper for uſe, it is to be firſt wetted by dipping ſeveral ſheets together in water: theſe are afterwards laid in a heap over each other; and to make them take the water equally, they are all preſſed cloſe down with a weight at the top. The ink is made of oil and lamp-black; for the manner of preparing which, ſee *Printing-Ink*. The balls, by which the ink is applied on the forms, are a kind of wooden funnels with handles, the cavities of which are filled with wool or hair, as is alſo a piece of alum leather or pelt nailed over the cavity, and made extremely ſoft by ſocking in urine and by being well rubbed. One of theſe the preſſman takes in each hand; and applying one of them to the ink-block, daubs and works them together to diſtribute the ink equally; and then blackens the form which is placed on the preſs, by beating with the balls upon the face of the letter.

Plate CCCCXV. The printing-preſs, repreſented nº 2. is a very curious though complex machine. The body conſiſts of two ſtrong cheeks *a a*, placed perpendicularly, and joined together by four croſs-pieces; the cap *b*; the head *c*, which is moveable, being partly ſuſtained by two iron pins or long bolts, that paſs the cap; the till or ſhelf *d d*, by which the ſpindle and its apparatus are kept in their proper poſition; and the winter *e*, which bears the carriage, and ſuſtains the effort of the preſs beneath. The ſpindle *f* is an upright piece of iron pointed with ſteel, having a male ſcrew which goes into the female one in the head about four inches. Through the eye *g* of this ſpindle is faſtened the bar *k*, by which the preſſman makes the impreſſion. The ſpindle paſſes through a hole in the middle of the till; and its point works into a braſs pan or nut, ſupplied with oil, which is fixed to an iron plate let into the top of the platten. The body of the ſpindle is ſuſtained in the centre of an open frame of poliſhed iron, 1, 1, 2, 2, 3, 3, fixed to it in ſuch a manner as, without obſtructing its free play, to keep it in a ſteady direction; and at the ſame time to ſerve for ſuſpending the platten. This frame conſiſts of two parts; the upper called the *garter*, 1, 1; the under, called the *crane*, 2, 2. Theſe are connected together by two ſhort legs or bolts, 3, 3; which being fixed below in the two ends of the crane, paſs upward, through two holes in the till, and are received at top into two eyes at the ends of the garter, where they are ſecured by ſcrews. The carriage *l l* is placed a foot below the platten, having its fore-part ſupported by a prop called the *fore-ſtay*, while the other reſts on the winter. On this carriage, which ſuſtains the plank, are nailed two long iron bars or ribs; and on the plank are nailed ſhort pieces of iron or ſteel called *cramp irons*, equally tempered with the ribs, and which ſlide upon them when the plank is turned in or out. Under the carriage is fixed a long piece of iron called the *ſpit*, with a double wheel in the middle, round which leather-girts are faſtened, nailed to each end of the plank: and to the outſide of the ſpit is fixed a rounce *m*, or handle to turn round the wheel. Upon the plank is a ſquare frame or coffin, in which is incloſed a poliſhed ſtone on which the form *n* is laid; at the end of the coffin are three frames, *viz.* the two tympans and friſket: the tympans *o* are ſquare, and made of three ſlips of very thin wood, and at the top a piece of iron ſtill thinner; that called the *outer tympan* is faſtened with hinges to the coffin: they are both covered with parchment; and between the two are placed blankets, which are neceſſary to take off the impreſſion of the letters upon the paper. The friſket *p* is a ſquare frame of thin iron, faſtened with hinges to the tympan: it is covered with paper cut in the neceſſary places, that the ſheet, which is put between the friſket and the great or outward tympan, may receive the ink, and that nothing may hurt the margins. To regulate the margins, a ſheet of paper is faſtened upon this tympan, which is called the *tympan ſheet*; and on each ſide is fixed an iron point, which makes two holes in the ſheet, which is to be placed on the ſame points when the impreſſion is to be made on the other ſide. In preparing the preſs for working, the parchment which covers the outer tympan is wetted till it is very ſoft, in order to render the impreſſion more equable; the blankets are then put in, and ſecured from ſlipping by the inner tympan: then while one preſsman is beating the letter with the balls *q*, covered with ink taken from the ink-block, the other perſon places a ſheet of white paper on the tympan-ſheet; turns down the friſket upon it, to keep the paper clean and prevent its ſlipping; then bringing the tympans upon the form, and turning the rounce, he brings the form with the ſtone, &c. weighing about 300 lbs. weight, under the platten; pulls with the bar, by which means the platten preſſes the blankets and paper cloſe upon the letter, whereby half the form is printed; then eaſing the bar, he draws the form ſtill forward; gives a ſecond pull; and letting go the bar, turns back the form, takes up the tympans and friſket, takes out the printed ſheet, and lays on a freſh one; and this is repeated till he has taken off the impreſſion upon the full number of ſheets the edition is to conſiſt of. One ſide of the ſheet being thus printed, the form for the other is laid upon the preſs, and worked off in the ſame manner.

Printing.

Chineſe PRINTING, is performed from wooden planks or blocks, cut like thoſe uſed in printing of callico, paper, cards, &c.

Rolling-preſs PRINTING, is employed in taking off prints or impreſſions from copperplates engraven, etched, or ſcraped, as in mezzotintos. See ENGRAVING.

This art is ſaid to have been as ancient as the year 1540, and to owe its origin to Finiguerra, a Florentine goldſmith, who pouring ſome melted brimſtone on an engraven plate, found the exact impreſſion of the engraving left in the cold brimſtone, marked with black taken out of the ſtrokes by the liquid ſulphur: upon this he attempted to do the ſame on ſilver plates with wet paper, by rolling it ſmoothly with a roller; and this ſucceeded: but this art was not uſed in England till the reign of king James I. when it was brought from Antwerp by Speed. The form of the rolling-

Printing. preſs, the compoſition of the ink uſed therein, and the manner of applying both in taking off prints, are as follow:

Plate CCCCXV. The rolling-preſs AL, nº 3. may be divided into two parts, the body and carriage: the body conſiſts of two wooden cheeks PP, placed perpendicularly on a ſtand or foot LM, which ſuſtains the whole preſs. From the foot likewiſe are four other perpendicular pieces *c*, *c*, *c*, *c*, joined by other croſs or horizontal ones *d*, *d*, *d*, which ſerve to ſuſtain a ſmooth even plank or table HIK, about four feet and a half long, two feet and a half broad, and an inch and a half thick. Into the cheeks go two wooden cylinders or rollers, DE, FG, about ſix inches in diameter, borne up at each end by the cheeks, whoſe ends, which are leſſened to about two inches diameter, and called *trunnions*, turn in the cheeks about two pieces of wood in form of half-moons, lined with poliſhed iron to facilitate the motion. Laſtly, to one of the trunnions of the upper roller is faſtened a croſs, conſiſting of two levers AB, or pieces of wood, traverſing each other, the arms of which croſs ſerve inſtead of the bar or handle of the letter-preſs, by turning the upper roller, and when the plank is between the two rollers, giving the ſame motion to the under one, by drawing the plank forward and backward.

The ink uſed for copperplates, is a compoſition made of the ſtones of peaches and apricots, the bones of ſheep and ivory, all well burnt, and called *Frankfort black*, mixed with nut-oil that has been well boiled, and ground together on a marble, after the ſame manner as painters do their colours.

The method of printing from copperplates is as follows: They take a ſmall quantity of this ink on a rubber made of linen-rags, ſtrongly bound about each other, and therewith ſmear the whole face of the plate as it lies on a grate over a charcoal fire. The plate being ſufficiently inked, they firſt wipe it over with a foul rag, then with the palm of their left hand, and then with that of the right; and to dry the hand and forward the wiping, they rub it from time to time in whiting. In wiping the plate perfectly clean, yet without taking the ink out of the engraving, the addreſs of the workman conſiſts. The plate thus prepared, is laid on the plank of the preſs; over the plate is laid the paper, firſt well moiſtened, to receive the impreſſion; and over the paper two or three folds of flannel. Things thus diſpoſed, the arms of the croſs are pulled, and by that means the plate with its furniture paſſed through between the rollers, which pinching very ſtrongly, yet equally, preſſes the moiſtened paper into the ſtrokes of the engraving, whence it licks out the ink.

Prints, the impreſſions taken from a copperplate. See the laſt article, and Engraving.

Strutt's Dict. of Engravers. From the facility of being multiplied, prints have derived an advantage over paintings by no means inconſiderable. They are found to be more durable; which may, however, in ſome degree be attributed to the different methods in which they are preſerved. Many of the beſt paintings of the early maſters have generally had the misfortune to be either painted on walls, or depoſited in large and unfrequented, and conſequently damp and deſtructive, buildings; whilſt a print, paſſing, at diſtant intervals, from the *porte feuille* of one collector to that of another, is preſerved without any great exertion of its owner: And hence it happens, that whilſt the pictures of Raphael have mouldered from their walls, or deſerted their canvas, the prints of his friend and cotemporary Mark Antonio Raimondi continue in full perfection to this day, and give us a lively idea of the beauties of thoſe paintings, which, without their aſſiſtance, had been loſt to us for ever; or at leaſt, could have been only known to us, like thoſe of Zeuxis and Apelles, by the deſcriptions which former writers on theſe ſubjects have left us. Printing, Prior.

Independent of the advantages which prints afford us, when conſidered as accurate repreſentations of paintings, and imitations of ſuperior productions, they are no leſs valuable for their poſitive merit, as immediate repreſentations of nature. For it muſt be recollected, that the art of engraving has not always been confined to the copying other productions, but has frequently itſelf aſpired to originality, and has, in this light, produced more inſtances of its excellence than in the other. Albert Durer, Goltzius, and Rembrandt, amongſt the Dutch and Germans; Parmigiano and Della Bella amongſt the Italians, and Callot amongſt the French, have publiſhed many prints, the ſubjects of which, there is great reaſon to ſuppoſe, were never painted. Theſe prints may therefore be conſidered as original pictures of thoſe maſters, deficient only in thoſe particulars in which a print muſt neceſſarily be inferior to a painting.

The preceding diſtinction may perhaps throw ſome light on the proper method of arranging and claſſing a collection of prints, which has been a matter of no ſmall difficulty. As an art imitating another, the principal ſhould take the lead, and the deſign, compoſition, and drawing, in a print, being previous requiſites to the manner of execution and finiſhing; prints engraved after paintings ſhould be arranged under the name of the painter; and every perſon who looks upon engraving only as auxiliary to painting, will conſequently adopt this mode of arrangement. But when engraving is conſidered as an original art, as imitating nature without the intervention of other methods, then it will certainly be proper to regulate the arrangement according to the names of the engravers.

Prior, in general, ſomething before or nearer the beginning than another, to which it is compared.

Prior, more particularly denotes the ſuperior of a convent of monks, or the next under the abbot. See Abbot.

Priors are either *clauſtral* or *conventual*. *Conventual* are the ſame as abbots. *Clauſtral* prior, is he who governs the religious of an abbey or priory *in commendam*, having his juriſdiction wholly from the abbot.

Grand Prior, is the ſuperior of a large abbey, where ſeveral ſuperiors are required.

Prior (Matthew), an eminent Engliſh poet, was born at London in 1664. His father dying while he was very young, an uncle a vintner, having given him ſome education at Weſtminſter ſchool, took him home in order to breed him up to his trade. However, at his leiſure hours he proſecuted his ſtudy of the claſſics, and eſpecially of his favourite Horace. This introduced

Prior. troduced him to ſome polite company, who frequented his uncle's houſe; among whom the earl of Dorſet took particular notice of him, and procured him to be ſent to St John's college in Cambridge, where, in 1686, he took the degree of A. B. and afterwards became fellow of that college. Upon the revolution, Mr Prior was brought to court by the earl of Dorſet; and in 1690 he was made ſecretary to the earl of Berkeley, plenipotentiary at the Hague; as he was afterward to the ambaſſador and plenipotentiaries at the treaty of Ryſwick in 1697; and the year following to the earl of Portland, ambaſſador to the court of France. He was in 1697 made ſecretary of ſtate for Ireland; and in 1700 was appointed one of the lords commiſſioners of trade and plantations. In 1710, he was ſuppoſed to have had a ſhare in writing *The Examiner*. In 1711, he was made one of the commiſſioners of the cuſtoms; and was ſent miniſter plenipotentiary to France, for the negotiating a peace with that kingdom. Soon after the acceſſion of George I. to the throne in 1714, he preſented a memorial to the court of France, requiring the demoliſhing of the canal and new works at Mardyke. The year following he was recalled; and upon his arrival was taken up by a warrant from the houſe of commons, and ſtrictly examined by a committee of the privy-council. Robert Walpole, Eſq; moved the houſe of commons for an impeachment againſt him; and Mr Prior was ordered into cloſe cuſtody. In 1717, he was excepted out of the act of grace; however, at the cloſe of that year, he was ſet at liberty. The remainder of his days he ſpent in tranquillity and retirement; and died in 1721. His poems are well known, and juſtly admired. He is ſaid to have written the following epitaph for himſelf:

"Nobles and heralds, by your leave,
Here lie the bones of Matthew Prior,
The ſon of Adam and of Eve:
Let Bourbon or Naſſau go higher."

Alien PRIORIES, were cells of the religious houſes in England which belonged to foreign monaſteries: for when manors or tithes were given to foreign convents, the monks, either to increaſe their own rule, or rather to have faithful ſtewards of their revenues, built a ſmall convent here for the reception of ſuch a number as they thought proper, and conſtituted priors over them.—Within theſe cells there was the ſame diſtinction as in thoſe priories which were cells ſubordinate to ſome great abbey; ſome of theſe were conventual, and, having priors of their own chooſing, thereby became entire ſocieties within themſelves, and received the revenues belonging to their ſeveral houſes for their own uſe and benefit, paying only the ancient apport (A), acknowledgment, or obvention, at firſt the ſurpluſage, to the foreign houſe; but others depended entirely on the foreign houſes, who appointed and removed their priors at pleaſure. Theſe tranſmitted all their revenues to the foreign head houſes; for which reaſon their eſtates were generally ſeized to carry on the wars between England and France, and reſtored to them again on return of peace. Theſe alien priories were moſt of them founded by ſuch as had foreign abbeys founded by themſelves or by ſome of their family. Priſcianus.

The whole number is not exactly aſcertained; the Monaſticon hath given a liſt of 100: Weever, p. 338. ſays 110.

Some of theſe cells were made indigenous or denizon, or endenized. The alien priories were firſt ſeized by Edward I. 1285, on the breaking out of the war between France and England; and it appears from a roll, that Edward II. alſo ſeized them, though this is not mentioned by our hiſtorians; and to theſe the act of reſtitution 1 Ed. III. ſeems to refer.

In 1337, Edward III. confiſcated their eſtates, and let out the priories themſelves with all their lands and tenements, at his pleaſure, for 23 years; at the end of which term, peace being concluded between the two nations, he reſtored their eſtates 1361, as appears by his letters patent to that of Montacute, county of Somerſet, printed at large in Rymer, vol. vi. p. 311. and tranſlated in Weever's *Funeral Monuments*, p. 339. At other times he granted their lands, or lay penſions out of them, to divers noblemen. They were alſo ſequeſtered during Richard II.'s reign, and the head monaſteries abroad had the king's licence to ſell their lands to other religious houſes here, or to any particular perſons who wanted to endow others.

Henry IV. began his reign with ſhowing ſome favour to the alien priories, reſtoring all the conventual ones, only reſerving to himſelf in time of war what they paid in time of peace to the foreign abbeys.

They were all diſſolved by act of parliament 2 Henry V. and all their eſtates veſted in the crown, except ſome lands granted to the college of Fotheringhay. The act of diſſolution is not printed in the ſtatute books, but it is to be found entire in Rymer's *Fœdera*, IX. 283. and in the Parliament Rolls, vol. iv. p. 22. In general, theſe lands were appropriated to religious uſes. Henry VI. endowed his foundations at Eton and Cambridge with the lands of the alien priories, in purſuance of his father's deſign to appropriate them all to a noble college at Oxford. Others were granted in fee to the prelates, nobility, or private perſons. Such as remained in the crown were granted by Henry VI. 1440, to archbiſhop Chichley, &c. and they became part of his and the royal foundations. See *Some Account of Alien-Priories*, &c. in two volumes octavo.

PRIORITY, the relation of ſomething conſidered as prior to another.

PRIORITY, in law, denotes an antiquity of tenure, in compariſon of another leſs ancient.

PRISCIANUS, an eminent grammarian, born at Cæſarea, taught at Conſtantinople with great reputation about the year 525. Laurentius Valla calls Priſcian, Donatus, and Servius, *triumviri in re grammatica*; and thinks none of the ancients who wrote after them fit to be mentioned with them. He compoſed a work *De arte grammatica*, which was firſt printed by Aldus at

(A) *Apportus* or *apportagium* (from *portare*), an acknowledgment, oblation, or obvention, to the mother houſe or church. *Du Cange*.

Priſcillianiſts || Priſtis.

at Venice in 1476; and another *De naturalibus quæſtionibus*, which he dedicated to Choſroes king of Perſia: beſide which, he tranſlated Dionyſius's deſcription of the world into Latin verſe. A perſon who writes falſe Latin, is proverbially ſaid to "break Priſcian's head."

PRISCILLIANISTS, in church-hiſtory, Chriſtian heretics, ſo called from their leader Priſcillian, a Spaniard by birth, and biſhop of Avila. He is ſaid to have practiſed magic, and to have maintained the principal errors of the Manichees; but his peculiar tenet was, That it is lawful to make falſe oaths in order to ſupport one's cauſe and intereſts.

PRISM, an oblong ſolid, contained under more than four planes, whoſe baſes are equal, parallel, and alike ſituated. See OPTICS, n° 142.

PRISON, a gaol, or place of confinement.

Lord Coke obſerves, that a priſon is only a place of ſafe cuſtody, *ſalva cuſtodia*, not a place of puniſhment. If this be ſo, and it cannot be queſtioned, priſons ought not to be, what they are in moſt parts of of Europe, loathſome dungeons. Any place where a perſon is confined may be ſaid to be a priſon; and when a proceſs is iſſued againſt one, he muſt, when arreſted thereon, either be committed to priſon, or be bound in a recognizance with ſureties, or elſe give bail, according to the nature of the caſe, to appear at a certain day in court, there to make anſwer to what is alleged againſt him. Where a perſon is taken and ſent to priſon, in a civil caſe, he may be releaſed by the plaintiff in the ſuit; but if it be for treaſon or felony, he may not regularly be diſcharged, until he is indicted of the fact and acquitted. See INDICTMENT, and the next article.

PRISONER, a perſon reſtrained or kept in priſon upon an action civil or criminal, or upon commendment: and one may be a priſoner on matter of record or matter of fact. A priſoner upon matter of record, is he who, being preſent in court, is by the court committed to priſon; and the other is one carried to priſon upon an arreſt, whether it be by the ſheriff, conſtable, or other officer.

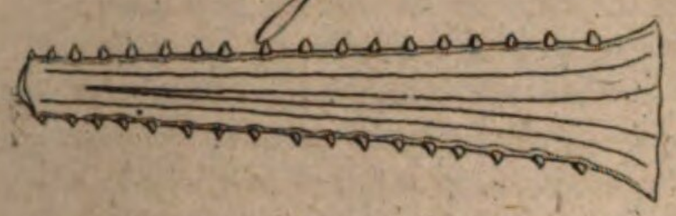
PRISTIS, the SAWFISH, is generally conſidered as a ſpecies of the *ſqualus* or *ſhark* genus, comprehending under it ſeveral varieties. Mr Latham, however, is of opinion that it ought to be conſidered as a diſtinct genus itſelf, and that the characteriſtics of the ſeveral varieties are ſufficient to conſtitute them diſtinct ſpecies. According to him therefore the *priſtis* is a genus belonging to the order of *amphibia nantes*; and its characters are as follow: A long plane beak or ſnout, with ſpines growing like teeth out of both edges; four or five *ſpiracula*, or breathing apertures, in the ſides of the neck: the body is oblong and almoſt round, with a rough coriaceous ſkin; the mouth is ſituated in the lower part of the head; and the noſtrils, before the mouth, are half covered with a membranaceous lobe; behind the eyes are two oval holes; the ventral fins approach one another, and in the male are placed about the organs of generation; there are no fins at the anus. Of this genus our author enumerates five ſpecies.

1. *Priſtis antiquorum.* The head is rather flat at top; the eyes large, with yellow irides; behind each is a hole, which ſome have ſuppoſed may lead to an organ of hearing. The mouth is well furniſhed with teeth, but they are blunt, ſerving rather to bruiſe its prey than to divide it by cutting. Before the mouth are two foramina, ſuppoſed to be the noſtrils. The *roſtrum*, beak, or ſnout, is in general about one-third of the total length of the fiſh, and contains in ſome 18, in others as far as 23 or 24 ſpines on each ſide; theſe are very ſtout, much thicker at the back-part, and channelled, inclining to an edge forwards. The fins are ſeven in number—viz. two dorſal, placed at ſome diſtance from each other—two pectoral, taking riſe juſt behind the breathing-holes, which are five in number—two ventral, ſituated almoſt underneath the firſt dorſal—and laſtly the caudal, occupying the tail both above and beneath, but longeſt on the upper part. The general colour of the body is a duſky grey, or browniſh, growing paler as it approaches the belly, where it is nearly white. 2. *Pectinatus*, which, with the former ſpecies, grows to the largeſt ſize of any that have yet come under the inſpection of the naturaliſt, ſome ſpecimens meaſuring 15 feet in length. The pectinatus differs from the priſtis antiquorum, in having the ſnout more narrow in proportion at the baſe, and the whole of it more ſlender in all its parts; whereas the firſt is very broad at the baſe, and tapers conſiderably from thence to the point. The ſpines on each ſide alſo are longer and more ſlender, and vary from 25 to 34 in the different ſpecimens: we have indeed been informed of one which contained no leſs than 36 ſpines on each ſide of the ſnout; but we muſt confeſs that we have never been fortunate enough to have ſeen ſuch a ſpecimen. 3. *Cuſpidatus*, of which our author has ſeen only two ſpecimens, the one about a foot and a half in length, and the other more than two feet and a half. In both of theſe were 28 ſpines on each ſide; but the diſtinguiſhing feature is in the ſpines themſelves, being particularly flat and broad, and ſhaped at the point more like the lancet uſed by ſurgeons in bleeding, than any other figure. We believe that no other author has hitherto taken notice of this ſpecies. 4. *Microdon*, of which the total length is 28 inches, the ſnout occupying 10; from the baſe of this to that of the pectoral fins four inches; between the pectoral and ventral fins ſix. The two dorſal fins occupy nearly the ſame proportions in reſpect to each other; but the hinder one is the ſmalleſt, and all of them are greatly hollowed out at the back-part, much more ſo than in the two firſt ſpecies. The ſnout differs from that of every other, in ſeveral particulars: it is longer in proportion, being more than one-third of the whole fiſh. The ſpines do not ſtand out from the ſides more than a quarter of an inch, and from this circumſtance ſeem far leſs capable of doing injury than any other ſpecies yet known. 5. *Cirratus*, of which, continues our author, we have only met with one ſpecimen, which was brought from Port Jackſon in New Holland. It is a male, and the total length about 40 inches: the ſnout, from the tip of it to the eye, 11: the ſpines widely different from any of the others; they are indeed placed, as uſual, on the edge, but are continued on each ſide even beyond the eyes. The longer ones are ſlender, ſharp, ſomewhat bent, and about 20 in number; and between theſe are others not half the length of the primal ones, between ſome three or four, between others as far as ſix; and in general the middle one of theſe ſmaller ſeries is the longeſt: beſide theſe a

Priſtis.

ſeries

Fig. 4.



Pristis.

Fig. 2.

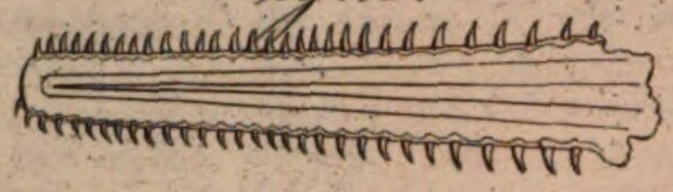


Fig. 1.

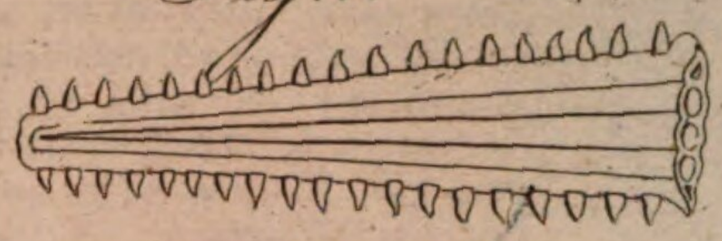
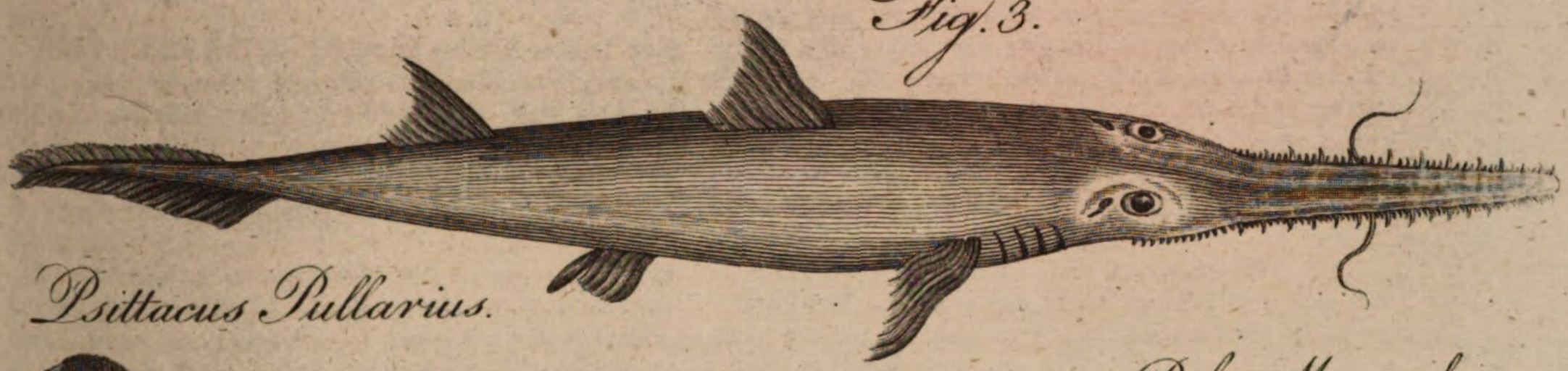


Fig. 3.



Psittacus Pullarius.

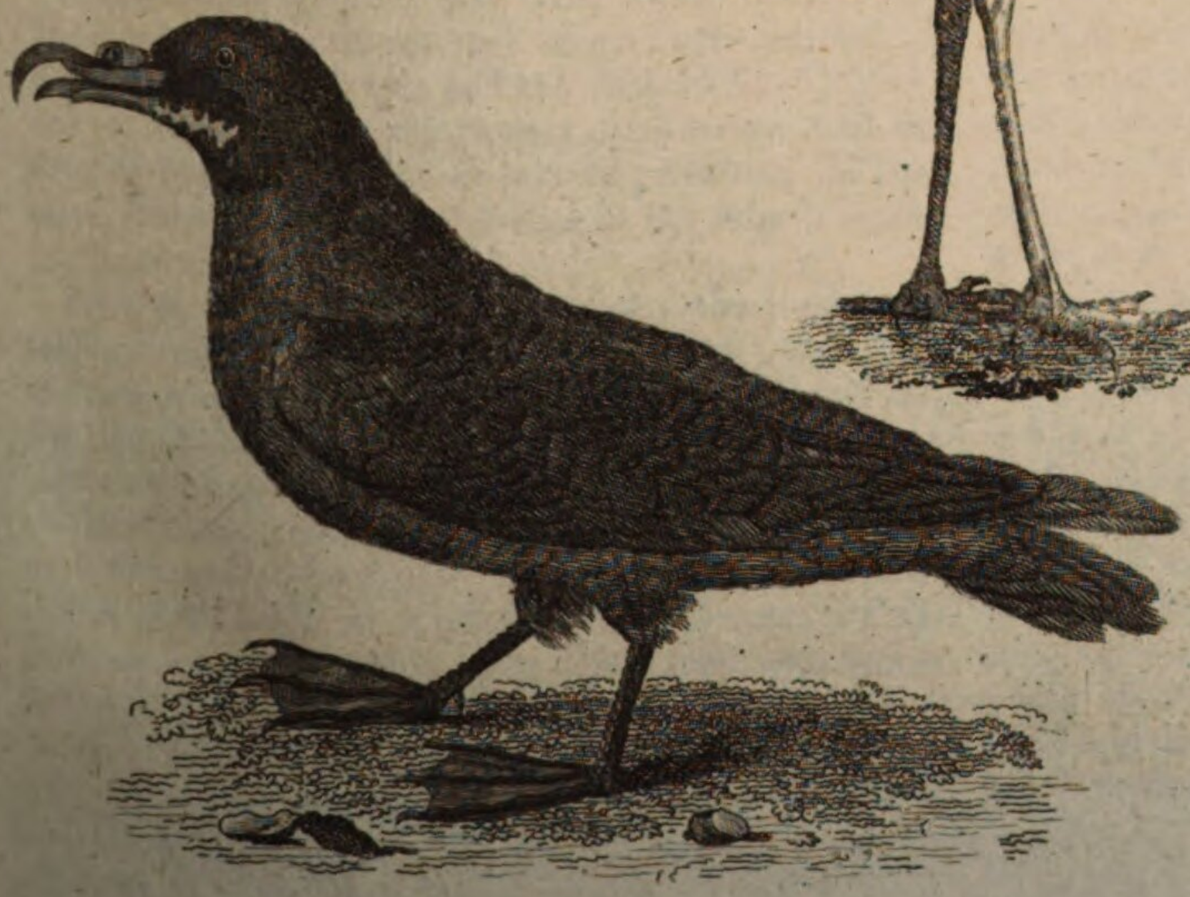
Pulex Monoculus.

Psophia Crepitans.

Chego or Pulex Minimus.

Ptini.

Procellaria Peteril.



Psittacus Guineensis.

A Bell Prin. Wall Scalpsr fecit.

Privateers ‖ Privative

series of minute ones may be perceived beneath, at the very edge. In the ſnout likewiſe another ſingularity occurs:—about the middle of it, on each ſide, near the edge, ariſes a flexible, ligamentous cord, about three inches and a half in length, appearing not unlike the beards at the mouth of ſome of the gadus or cod genus, and no doubt as pliant in the recent ſtate. The colour of the fiſh is a pale brown: the breathing apertures four in number: the mouth furniſhed with five rows of minute, but very ſharp teeth. See Plate CCCCXVI. where the ſnout marked 1 is that of the priſtis antiquorum; that marked 2, of pectinatus; and that marked 4, of microdon: the entire fiſh is the cirratus.

PRIVATEERS, are a kind of private men of war, the perſons concerned wherein adminiſter at their own coſts a part of a war, by fitting out theſe ſhips of force, and providing them with all military ſtores; and they have, inſtead of pay, leave to keep what they take from the enemy, allowing the admiral his ſhare, &c.

Privateers may not attempt any thing againſt the laws of nations; as to aſſault an enemy in a port or haven, under the protection of any prince or republic, whether he be friend, ally, or neuter; for the peace of ſuch places muſt be inviolably kept: therefore, by a treaty made by King William and the States of Holland, before a commiſſion ſhall be granted to any privateer, the commander is to give ſecurity, if the ſhip be not above 150 tons, in L. 1500, and if the ſhip exceeds that burden, in L. 3000, that they will make ſatisfaction for all damages which they ſhall commit in their courſes at ſea, contrary to the treaties with that ſtate, on pain of forfeiting their commiſſions; and the ſhip is made liable.

Jacob's Law Dict.

Beſides theſe private commiſſions, there are ſpecial commiſſions for privateers, granted to commanders of ſhips, &c. who take pay; who are under a marine diſcipline; and if they do not obey their orders, may be puniſhed with death: and the wars in later ages have given occaſion to princes to iſſue theſe commiſſions, to annoy the enemies in their commerce, and hinder ſuch ſupplies as might ſtrengthen them or lengthen out the war; and likewiſe to prevent the ſeparation of ſhips of greater force from their fleets or ſquadrons.

Ships taken by privateers were to be divided into five parts; four parts whereof to go to the perſons intereſted in the privateer, and the fifth to his Majeſty: and as a farther encouragement, privateers, &c. deſtroying any French man of war or privateer, ſhall receive, for every piece of ordnance in the ſhip ſo taken, L. 10 reward, &c.

By a particular ſtatute lately made, the lord admiral, or commiſſioners of the admiralty, may grant commiſſions to commanders of privateers, for taking ſhips, &c. which being adjudged prize, and the tenth part paid to the admiral, &c. wholly belong to the owners of the privateers and the captors, in proportions agreed on between themſelves.

PRIVATION, in a general ſenſe, denotes the abſence or want of ſomething; in which ſenſe darkneſs is only the privation of light.

PRIVATIVE, in grammar, a particle, which, prefixed to a word, changes it into a contrary ſenſe. Thus, among the Greeks, the α is uſed as a privative; as in α-θεος, *atheiſt*, *acephalus*, &c.—The Latins have their privative *in*; as, *incorrigibilis*, *indeclinabilis*, &c.—The Engliſh, French, &c. on occaſion borrow both the Latin and Greek privatives.

Privernum ‖ Privy.

PRIVERNUM, (Livy, Virgil); a town of the Volſci, in Latium, to the eaſt of Setia. *Privernates*, the people. Whoſe ambaſſadors being aſked, What puniſhment they deſerved for their revolt? anſwered, What thoſe deſerve who deem themſelves worthy of liberty. And again, being aſked by the Roman conſul, ſhould the puniſhment be remitted, What peace was to be expected with them? If you grant a good peace, you may hope to have it ſincere and laſting; but if a bad one, you may well expect it of ſhort continuance. At which anſwer, the Romans were ſo far from being diſpleaſed, that by a vote of the people they had the freedom of the city granted them. *Privernas*, *atis*, the epithet. The town is now called *Piperno Vecchio*, ſituated in the Campania of Rome. E. Long. 10. 0. N. Lat. 41. 30.

PRIVET, in botany. See LIGUSTRUM.

PRIVILEGE, in law, ſome peculiar benefit granted to certain perſons or places, contrary to the uſual courſe of the law.

Privileges are ſaid to be *perſonal* or *real*.

Perſonal privileges are ſuch as are extended to peers, ambaſſadors, members of parliament, and of the convocation, &c. See LORDS, AMBASSADOR, PARLIAMENT, ARREST, &c.

A *real* privilege is that granted to ſome particular place; as the king's palace, the courts at Weſtminſter, the univerſities, &c.

Privileges of the Clergy. See CLERGY.

PRIVY, in law, is a partaker, or perſon having an intereſt, in any action or thing. In this ſenſe they ſay, privies in blood: every heir in tail is privy to recover the land intailed. In old law-books, merchants privy are oppoſed to merchants ſtrangers. Coke mentions four kinds of privies. Privies in blood, as the heir to his father; privies in repreſentation, as executors and adminiſtrators to the deceaſed; privies in eſtate, as he in reverſion, and he in remainder donor and donee; leſſor and leſſee: laſtly, privy in tenure, as the lord by eſcheat; *i.e.* when land eſcheats to the lord for want of heirs.

Privy-Council. See COUNCIL. The king's will is the ſole conſtituent of a privy counſellor; and it alſo regulates their number, which in ancient times was about twelve. Afterwards it increaſed to ſo large a number, that it was found inconvenient for ſecrecy and diſpatch; and therefore Charles II. in 1679, limited it to 30; whereof 15 were principal officers of ſtate, and to be counſellors *ex officio*; and the other 15 were compoſed of 10 lords and five commoners of the king's chooſing. Since that time however the number has been much augmented, and now continues indefinite. At the ſame time alſo, the ancient office of lord preſident of the council was revived, in the perſon of Anthony earl of Shafteſbury. Privy-counſellors are made by the king's nomination, without either patent or grant; and, on taking the neceſſary oaths, they become immediately privy-counſellors during the life of the king that chooſes them, but ſubject to removal at his diſcretion.

Privy. Any natural born ſubject of England is capable of being a member of the privy-council; taking the proper oaths for ſecurity of the government, and the teſt for ſecurity of the church. By the act of ſettlement, 12 and 13 W. III. cap. 2. it is enacted, that no perſon born out of the dominions of the crown of England, unleſs born of Engliſh parents, even though naturalized by parliament, ſhall be capable of being of the privy-council. The duty of a privy-counſellor appears from the oath of office, which conſiſts of ſeven articles. 1. To adviſe the king according to the beſt of his cunning and diſcretion. 2. To adviſe for the king's honour and good of the public, without partiality, through affection, love, meed, doubt, or dread. 3. To keep the king's counſel ſecret. 4. To avoid corruption. 5. To help and ſtrengthen the execution of what ſhall be there reſolved. 6. To withſtand all perſons who would attempt the contrary. And, laſtly, in general, 7. To obſerve, keep, and do all that a good and true counſellor ought to do to his ſovereign lord.

The privy-council is the *primum mobile* of the ſtate, and that which gives the motion and direction to all the inferior parts. It is likewiſe a court of juſtice of great antiquity; the primitive and ordinary way of government in England being by the king and privy-council. It has been frequently uſed by all our kings for determining controverſies of great importance: the ordinary judges have ſometimes declined giving judgment till they had conſulted the king and privy-council; and the parliament have frequently referred matters of high moment to the ſame, as being by long experience better able to judge of, and, by their ſecrecy and expedition, to tranſact ſome ſtate affairs, than the lords and commons. At preſent, the privy-council takes cognizance of few or no matters except ſuch as cannot well be determined by the known laws and ordinary courts; ſuch as matters of complaint and ſudden emergencies: their conſtant buſineſs being to conſult for the public good in affairs of ſtate. This power of the privy-council is to inquire into all offences againſt the government, and to commit the offenders to ſafe cuſtody, in order to take their trial in ſome of the courts of law. But their juriſdiction herein is only to inquire, and not to puniſh; and the perſons committed by them are intitled to their *habeas corpus* by ſtatute 16 Car. I. cap. 10. as much as if committed by an ordinary juſtice of the peace.

In plantation or admiralty cauſes, which ariſe out of the juriſdiction of this kingdom, and in matters of lunacy and idiocy, the privy-council has cognizance, even in queſtions of extenſive property, being the court of appeal in ſuch cauſes; or, rather, the appeal lies to the king's majeſty himſelf in council. From all the dominions of the crown, excepting Great Britain and Ireland, an appellate juriſdiction (in the laſt reſort) is veſted in this tribunal; which uſually exerciſes its judicial authority in a committee of the whole privy-council, who hear the allegations and proofs, and make their report to his majeſty in council, by whom the judgment is finally given.

Anciently, to ſtrike in the houſe of a privy-counſellor, or elſewhere in his preſence, was grievouſly puniſhed: by 3 Hen. VII. cap. 14. if any of the king's ſervants of his houſehold conſpire or imagine to take away the life of a privy-counſellor, it is felony, though nothing ſhall be done upon it; and by 9 Ann, cap. 16. it is enacted, that any perſons who ſhall unlawfully attempt to kill, or ſhall unlawfully aſſault, and ſtrike, or wound, any privy-counſellor in the execution of his office, ſhall be felons, and ſuffer death as ſuch. With advice of this council, the king iſſues proclamations that bind the ſubject, provided they be not contrary to law. In debates, the loweſt delivers his opinion firſt, the king laſt; and thereby determines the matter. A council is never held without the preſence of a ſecretary of ſtate. Privy Council Proc.

The diſſolution of the privy-council depends upon the king's pleaſure; and he may, whenever he thinks proper, diſcharge any particular member, or the whole of it, and appoint another. By the common law alſo it was diſſolved *ipſo facto* by the king's demiſe, as deriving all its authority from him. But now, to prevent the inconveniences of having no council in being at the acceſſion of a new prince, it is enacted, by 6 Ann, cap. 7. that the privy-council ſhall continue for ſix months after the demiſe of the crown, unleſs ſooner determined by the ſucceſſor. *Blackſt. Com.* book i. p. 229, &c.

The officers of the privy-council are four clerks of the council in ordinary, three clerks extraordinary, a keeper of the records, and two keepers of the council-chamber. See PRESIDENT,

Privy Seal, a ſeal which the king uſes previouſly to ſuch grants, &c. as are afterwards to paſs the great ſeal.

The privy ſeal is alſo ſometimes uſed in matters of leſs conſequence, which do not require the great ſeal.

Lord Privy Seal. See *Keeper of the Privy Seal.*

Clerks of the Privy Seal. See CLERK.

Privy Chamber. See CHAMBER.

PRIZE, or PRISE, in maritime affairs, a veſſel taken at ſea from the enemies of a ſtate, or from pirates; and that either by a man of war, a privateer, &c. having a commiſſion for that purpoſe.

Veſſels are looked on as prize, if they fight under any other ſtandard than that of the ſtate from which they have their commiſſion; if they have no charter-party, invoice, or bill of lading aboard; if loaded with effects belonging to the king's enemies, or with contraband goods.

In ſhips of war, the prizes are to be divided among the officers, ſeamen, &c. as his Majeſty ſhall appoint by proclamation; but among privateers, the diviſion is according to the agreement between the owners.

By ſtat. 13 Geo. II. c. 4. judges and officers, failing of their duty in reſpect to the condemnation of prizes, forfeit L. 500, with full coſts of ſuit; one moiety to the king, and the other to the informer.

PROA, FLYING, in navigation, is a name given to a veſſel uſed in the ſouth ſeas, becauſe with a briſk trade-wind it ſails near 20 miles an hour. In the conſtruction of the proa, the head and ſtern are exactly alike, but the ſides are very different; the ſide intended to be always the lee-ſide being flat; and the windward ſide made rounding, in the manner of other veſſels; and, to prevent her over-ſetting, which from her ſmall breadth, and the ſtraight run of her leeward ſide, would, without this precaution, infallibly happen, there is a frame laid out to her from windward, to the end of which is faſtened a log, faſhioned into the ſhape of a ſmall boat, and made hollow. The weight of the frame

Probability. frame is intended to balance the proa, and the ſmall boat is by its buoyancy (as it is always in the water) to prevent her overſetting to windward; and this frame is uſually called an outrigger. The body of the veſſel is made of two pieces joined endwiſe, and ſewed together with bark, for there is no iron uſed about her; ſhe is about two inches thick at the bottom, which, at the gunwale, is reduced to leſs than one. The ſail is made of matting, and the maſt, yard, boom, and outriggers, are all made of bamboo. See *Anſon's Voyage*, quarto, p. 341.

PROBABILITY is a word of nearly the ſame import with likelihood. It denotes the appearance of truth, or that evidence ariſing from the preponderation of argument which produces opinion. (See OPINION.) Locke claſſes all arguments under the heads of *demonſtrative* and *probable*: Hume with greater accuracy divides them into *demonſtrations*, *proofs*, and *probabilities*. Demonſtration produces *ſcience*; proof, *belief*; and probability, *opinion*.

Hardly any thing is ſuſceptible of ſtrict demonſtration beſides the mathematical ſciences, and a few propoſitions in metaphyſical theology. Phyſics reſt upon principles capable, ſome of them, of complete proof by experience, and others of nothing more than probability by analogical reaſoning. What has *uniformly* happened, we expect with the fulleſt confidence to happen again in ſimilar circumſtances; what has *frequently* happened, we likewiſe expect to happen again; but our expectation is not confident. Uniform experience is proof; frequent experience is probability. The ſtrongeſt man has *always* been able to lift the greateſt weight; and, therefore, knowing that one man is ſtronger than another, we expect, with confidence, that the former will lift more than the latter. The beſt diſciplined army has *generally* proved victorious, when all other circumſtances were equal. We therefore expect that an army of veterans will, upon fair ground, defeat an equal number of new levied troops: but as ſudden panics have ſometimes ſeized the oldeſt ſoldiers, this expectation is accompanied with doubt, and the utmoſt that we can ſay of the expected event is, that it is *probable*; whereas in the competition between the two men, we look upon it as *morally certain*. (See METAPHYSICS, part 1. chap. vii. ſec. 3.) When two or three perſons of known veracity atteſt the ſame thing as conſiſtent with their knowledge, their teſtimony amounts to *proof*, if not contradicted by the teſtimony of others; if contradicted, it can, at the utmoſt, amount only to probability. In common language we talk of *circumſtantial* proofs and *preſumptive* proofs; but the expreſſions are improper, for ſuch evidence amounts to nothing more than probability. Of probability there are indeed various degrees from the confines of certainty down to the confines of impoſſibility; and a variety of circumſtances tending to the ſame point, though they amount not to what, in ſtrictneſs of language, ſhould be called *proof*, afford to the mind a very high degree of evidence, upon which, with the addition of one direct teſtimony, the laws of many countries take away the life of a man.

PROBABILITY of an Event, in the *Doctrine of Chances*, is greater or leſs according to the number of chances by which it may happen or fail. (See EXPECTATION). The *probability of life* is liable to rules of computation. In the *Encyclopedie Methodique*, we find a table of the probabilities of the duration of life, conſtructed from that which is to be found in the ſeventh volume of the *Supplemens à l'Hiſtoire de M. de Buffon*; of which the following is an abridgement. Probate || Probity.

Of 23,994 children born at the ſame time, there will probably die

$\frac{1}{3}$	In one year - -	7998
$\frac{2}{3}$	Remaining $\frac{2}{3}$ or 15996	
$\frac{1}{2}$	In eight years - -	11997
$\frac{1}{2}$	Remaining $\frac{1}{2}$ or 11997	
$\frac{2}{3}$	In thirty eight years -	15996
$\frac{1}{3}$	Remaining $\frac{1}{3}$ or 7998	
$\frac{3}{4}$	In fifty years - -	17994
$\frac{1}{4}$	Remaining $\frac{1}{4}$ or 5998	
$\frac{5}{6}$	In ſixty one years - -	19995
$\frac{1}{6}$	Remaining $\frac{1}{6}$ or 3999	
$\frac{9}{10}$	In ſeventy years - -	21595
$\frac{1}{10}$	Remaining $\frac{1}{10}$ or 2399	
$\frac{39}{40}$	In eighty years -	22395
$\frac{1}{40}$	Remaining $\frac{1}{40}$ or 599	
$\frac{299}{300}$	In ninety years - -	23914
$\frac{1}{300}$	Remaining $\frac{1}{300}$ or 80	
	In an hundred years -	23992
	Remaining $\frac{1}{100000}$ or 2. See *Bills of* MORTALITY.	

PROBATE of a will or teſtament, in law, is the exhibiting and proving of laſt wills and teſtaments before the eccleſiaſtical judge delegated by the biſhop, who is ordinary of the place where the party died.

PROBATION, in the univerſities, is the examination and trial of a ſtudent who is about to take his degrees.

PROBATION, in a monaſtic ſenſe, ſignifies the year of a novitiate, which a religious muſt paſs in a convent, to prove his virtue and vocation, and whether he can bear the ſeverities of the rule.

PROBATION, in Scots law. See LAW, p. 714.

PROBATIONER, in the church of Scotland, a ſtudent in divinity, who bringing a certificate from a profeſſor in an univerſity of his good morals, and his having performed his exerciſes to approbation, is admitted to undergo ſeveral trials; and, upon his acquitting himſelf properly in theſe, receives a licence to preach.

PROBATUM EST (*It is proved*), a term frequently ſubjoined to a receipt for the cure of ſome diſeaſe.

PROBE, a ſurgeon's inſtrument for examining the circumſtances of wounds, ulcers, and other cavities, ſearching for ſtones in the bladder, &c.

PROBITY means honeſty, ſincerity, or veracity; and conſiſts in the habit of actions uſeful to ſociety, and in the conſtant obſervance of the laws which juſtice and conſcience impoſe on us. The man who obeys all the laws of ſociety with an exact punctuality is not therefore a man of probity; laws can only reſpect the external and definite parts of human conduct, but probity reſpects our more private actions, and ſuch as it is impoſſible in all caſes to define; and it appears to be in morals what charity is in religion. Probity teaches us to perform in ſociety thoſe actions which no external power can oblige us to perform, and is that quality in the human mind from which we claim the performance of the *rights* commonly called *imperfect*. See MORAL PHILOSOPHY.

Problem || Procellaria.

PROBLEM, in logic, is a propoſition that neither appears abſolutely true nor falſe; and, conſequently, may be aſſerted either in the affirmative or negative.

PROBLEM, in geometry, is a propoſition, wherein ſome operation or conſtruction is required; as to divide a line or angle, erect or let fall perpendiculars, &c. See GEOMETRY.

PROBOSCIS, in natural hiſtory, is the trunk or ſnout of an elephant, and ſome other animals and inſects.

Flies, gnats, &c. are furniſhed with a proboſcis or trunk; by means of which they ſuck the blood of animals, the juice of vegetables, &c. for their food.

PROBUS (Marcus Aurelius), from the ſon of a gardener, became, by his great valour as a ſoldier, and his eminent virtues, emperor of Rome, to which dignity he was raiſed by the army. After having ſubdued the barbarous nations that had made incurſions into different parts of the empire, where they committed horrid cruelties, and governed with great wiſdom and clemency, he was maſſacred in the 7th year of his reign, by ſome ſoldiers who were weary of the public works at which he made them labour, in 282.

PROCATARCTIC CAUSE, in medicine, the preexiſting, or prediſpoſing cauſe or occaſion of a diſeaſe.

PROCELEUSMATICUS, in the ancient poetry, a foot conſiſting of four ſhort ſyllables, or two pyrrhychiuſes; as *hominibus*.

PROCELLARIA, in ornithology; a genus of birds, belonging to the order of anſeres. The beak is ſomewhat compreſſed, and without teeth; the mandibles are equal, the ſuperior one being crooked at the point; the feet are palmated, the hind claw being ſeſſile, without any toe. Mr Latham (See his *Index Ornithologicus*, p. 820.) enumerates 24 ſpecies, which are principally diſtinguiſhed by their colour. The moſt remarkable are,

1. The cinerea, or petrel. The ſize of this bird is rather ſuperior to that of the common gull: the bill very ſtrong, much hooked at the end, and of a yellow colour. The noſtrils are compoſed of two large tubes, lodged in one ſheath: the head, neck, whole under ſide of the body, and tail, are white: the back and coverts of the wings aſh-coloured: the quill-feathers duſky: and the legs yellowiſh. In lieu of a back toe, it has only a ſort of ſpur, or ſharp ſtraight nail. Theſe birds feed on the blubber or fat of whales, &c. which being ſoon convertible into oil, ſupplies them conſtantly with means of defence, as well as proviſion for their young, which they caſt up into their mouths. They are likewiſe ſaid to feed on ſorrel, which they uſe to qualify the unctuous diet they live on. This ſpecies inhabits the iſle of St Kilda; makes its appearance there in November, and continues the whole year, except September and October; it lays a large, white, and very brittle egg; and the young are hatched the middle of June. No bird is of ſuch uſe to the iſlanders as this: the fulmar ſupplies them with oil for their lamps, down for their beds, a delicacy for their tables, a balm for their wounds, and a medicine for their diſtempers. The fulmar is alſo a certain prognoſticator of the change of the wind: if it comes to land, no weſt wind is expected for ſome time; and the contrary when it returns and keeps the ſea. The whole genus of petrels have a peculiar faculty of ſpouting from their bills, to a conſiderable diſtance, a large quantity of pure oil; which they do, by way of defence, into the face of any one that attempts to take them: ſo that they are, for the ſake of this panacæa, ſeized by ſurpriſe; as this oil is ſubſervient to the abovementioned medical purpoſes. Martin tells us, it has been uſed in London and Edinburgh with ſucceſs in rheumatic caſes. Frederick Martens, who had opportunity of ſeeing vaſt numbers of theſe birds at Spitzbergen, obſerves, that they are very bold, and reſort after the whale-fiſhers in great flocks; and that, when a whale is taken, they will, in ſpite of all endeavours, light on it and pick out large lumps of fat, even when the animal is alive: That the whales are often diſcovered at ſea by the multitudes of them flying; and that when one of the former are wounded, prodigious multitudes immediately follow its bloody track. He adds, that it is a moſt gluttonous bird, eating till it is forced to diſgorge itſelf. Procellaria.

2. The puffinus, or ſhear-water, is 15 inches in length; the breadth 31; the weight 17 ounces: the bill is an inch and three quarters long; noſtrils tubular, but not very prominent: the head, and whole upper ſide of the body, wings, tail, and thighs, are of a ſooty blackneſs; the under ſide from chin to tail, and inner coverts of the wings, white: the legs weak, and compreſſed ſidewiſe; duſky behind, whitiſh before. Theſe birds are found in the Calf of Man; and, as Mr Ray ſuppoſes, in the Scilly iſles. They reſort to the former in February; take a ſhort poſſeſſion of the rabbet-burrows, and then diſappear till April. They lay one egg, white and blunt at each end; and the young are fit to be taken the beginning of Auguſt; when great numbers are killed by the perſon who farms the iſle: they are ſalted and barrelled; and when they are boiled, are eaten with potatoes. During the day they keep at ſea, fiſhing; and towards evening return to their young; whom they feed, by diſcharging the contents of their ſtomachs into their mouths; which by that time is turned into oil: by reaſon of the backward ſituation of their legs, they ſit quite erect. They quit the iſle the latter end of Auguſt, or beginning of September; and, from accounts lately received from navigators, we have reaſon to imagine that, like the ſtorm-finch, they are diſperſed over the whole Atlantic ocean. This ſpecies inhabits alſo the Orkney iſles, where it makes its neſt in holes on the earth near the ſhelves of the rocks and headlands: it is called there the *lyre;* and is much valued, both on account of its being a food, and for its feathers. The inhabitants take and ſalt them in Auguſt for winter proviſions, when they boil them with cabbage. They alſo take the old ones in March; but they are then poor, and not ſo well taſted as the young: they appear firſt in thoſe iſlands in February.

3. The pelagica, or ſtormy petrel, is about the bulk of the houſe-ſwallow: the length ſix inches; the extent of wings, 13. The whole bird is black, except the coverts of the tail and vent-feathers, which are white: the bill is hooked at the end: the noſtrils tubular: the legs ſlender, and long. It has the ſame faculty of ſpouting oil from its bill as the other ſpecies: and Mr Brunnich tells us, that the inhabitants of the Ferroe iſles make this bird ſerve the purpoſes of a candle, by drawing a wick through the mouth and rump, which being lighted, the flame is fed by the fat and oil of the body. Except in breeding-time, it is always at ſea; and is ſeen all over the vaſt Atlantic ocean, at the greateſt

diſtance

Procellaria Process

distance from land; often following the veſſels in great flocks, to pick up any thing that falls from on board: for trial ſake, chopped ſtraw has been flung over, which they would ſtand on with expanded wings; but were never obſerved to ſettle on or ſwim in the water: it preſages bad weather, and cautions the ſeamen of the approach of a tempeſt, by collecting under the ſtern of the ſhips: it braves the utmoſt fury of the ſtorm, ſometimes ſkimming with incredible velocity along the hollows of the waves, ſometimes on the ſummits: Cluſius makes it the Camilla of the ſea.

Vel mare per medium fluctu ſuſpenſa tumenti
Ferret iter, celeres nec tingeret æquore plantas. VIRG.

She ſwept the ſeas; and, as ſhe ſkimm'd along,
Her flying feet unbath'd on billows hung. DRYDEN.

Theſe birds are the *cypſelli* of Pliny, which he places among the *apodes* of Ariſtotle; not becauſe they wanted feet, but were Κακοποδα, or had bad or uſeleſs ones; an attribute he gives to theſe ſpecies, on a ſuppoſition that they were almoſt always on the wing. In Auguſt 1772, Mr Pennant found them on the rocks called *Macdonald's Table*, off the north end of the iſle of Skie; ſo conjectures they breed there. They lurked under the looſe ſtones, but betrayed themſelves by their twittering noiſe.

In Mr White's *Journal of a Voyage to New South Wales* we have a figure of the fuliginous petrel, with a whitiſh beak; which he takes to be a variety of the *Procellaria Æquinoctialis* of Linnæus. It is nearly of the ſize of a raven; its colour is a deep ſooty brown or blackiſh; on the chin there is a ſmall patch of white running down a little on each ſide from the lower mandible; the beak is of yellowiſh white. See Plate CCCCXVI. Captain Bligh, in his *Voyage to the South Seas*, in S. Lat. 60. 1. and W. Long. 71. 45. ſaw both petrels and pintadas; ſome of which he took with baited hooks.

PROCESS, in law, denotes the proceedings in any cauſe, real or perſonal, civil or criminal, from the original writ to the end thereof.

In a more limited ſenſe, proceſs denotes that by which a man is called firſt into any temporal court.

It is the next ſtep for carrying on the ſuit, after ſuing out the original writ. See SUIT and WRIT.

It is the method taken by the law to compel a compliance with the original writ, of which the primary ſtep is by giving the party notice to obey it. This notice is given upon all real *præcipes*; and alſo upon all perſonal writs for injuries not againſt the peace, by *ſummons*; which is a warning to appear in court at the return of the original writ, given to the defendant by two of the ſheriff's meſſengers called *ſummoners*, either in perſon, or left at his houſe or land: in like manner as in the civil law the firſt proceſs is by perſonal citation, *in jus vocando*. This warning on the land is given, in real actions, by erecting a white ſtick or wand on the defendant's grounds (which ſtick or wand among the northern nations is called the *baculus nunciatorius*), and by ſtatute 31 Eliz. c. 3. the notice muſt alſo be proclaimed on ſome Sunday before the door of the pariſh-church.

Blackſt. Comment.

If the defendant diſobeys this verbal monition, the next proceſs is by writ of *attachment*, or *pone*; ſo called from the words of the writ, *pone per vadium et ſalvos plegios*, "put by gage and ſafe pledges A. B. the defendant," &c. This is a writ not iſſuing out of chancery, but out of the court of common-pleas, being grounded on the non-appearance of the defendant at the return of the original writ; and thereby the ſheriff is commanded to attach him, by taking *gage*, that is, certain of his goods, which he ſhall forfeit if he doth not appear; or by making him find *ſafe pledges* or ſureties, which ſhall be amerced in caſe of his non-appearance. This is alſo the firſt and immediate proceſs, without any previous ſummons, upon actions of treſpaſs *vi et armis*, or for other injuries, which, though not forcible, are yet treſpaſſes againſt the peace, as *deceit* and *conſpiracy*; where the violence of the wrong requires a more ſpeedy remedy, and therefore the original writ commands the defendant to be at once attached, without any precedent warning. Proceſs.

If, after attachment, the defendant neglects to appear, he not only forfeits this ſecurity, but is moreover to be farther compelled by writ of *diſtringas*, or diſtreſs infinite: which is a ſubſequent proceſs iſſuing from the court of common-pleas, commanding the ſheriff to diſtrain the defendant from time to time, and continually afterwards, by taking his goods and the profits of his lands, which are called *iſſues*, and which he forfeits to the king if he doth not appear. But the iſſues may be ſold, if the court ſhall ſo direct, in order to defray the reaſonable coſts of the plaintiff. In like manner, by the civil law, if the defendant abſconds, ſo that the citation is of no effect, *mittitur adverſarius in poſſeſſionem bonorum ejus*.

And here, by the common as well as the civil law, the proceſs ended in caſe of injuries without force: the defendant if he had any ſubſtance, being gradually ſtripped of it all by repeated diſtreſſes, till he rendered obedience to the king's writ; and, if he had no ſubſtance, the law held him incapable of making ſatisfaction, and therefore looked upon all farther proceſs as nugatory. And beſides, upon feodal principles, the perſon of a feudatory was not liable to be attached for injuries merely civil, leſt thereby his lord ſhould be deprived of his perſonal ſervices. But, in caſes of injury accompanied with force, the law, to puniſh the breach of the peace and prevent its diſturbance for the future, provided alſo a proceſs againſt the defendant's perſon, in caſe he neglected to appear upon the former proceſs of attachment, or had no ſubſtance whereby to be attached; ſubjecting his body to impriſonment by the writ of *capias ad reſpondendum*. But this immunity of the defendant's perſon, in caſe of peaceable though fraudulent injuries, producing great contempt of the law in indigent wrongdoers, a *capias* was alſo allowed, to arreſt the perſon in actions of account, though no breach of the peace be ſuggeſted, by the ſtatutes of Marlbridge, 52 Hen. III. c. 23. and Weſtm. 2. 13 Edw. I. c. 11. in actions of debt and detinue, by ſtatute 25 Edw. III. c. 17. and in all actions on the caſe, by ſtatute 19 Hen. VII c. 9. Before which laſt ſtatute a practice had been introduced of commencing the ſuit by bringing an original writ of treſpaſs *quare clauſum fregit*, by breaking the plaintiff's cloſe, *vi et armis*; which by the old common law ſubjected the defendant's perſon to be arreſted by writ of *capias*: and then afterwards, by connivance of the court, the plaintiff might proceed to proſecute for any other leſs forcible injury. This practice (through cuſtom rather than neceſſity, and for ſaving ſome trouble and expence,

Proceſs. pence, in ſuing out a ſpecial original adapted to the particular injury) ſtill continues in almoſt all caſes, except in actions of debt; though now, by virtue of the ſtatutes above cited and others, a *capias* might be had upon almoſt every ſpecies of complaint.

If therefore the defendant, being ſummoned or attached, makes default, and neglects to appear; or if the ſheriff returns a *nihil*, or that the defendant hath nothing whereby he may be ſummoned, attached, or diſtrained, the *capias* now uſually iſſues: being a writ commanding the ſheriff to take the body of the defendant, if he may be found in his bailiwick or county, and him ſafely to keep, ſo that he may have him in court on the day of the return, to anſwer to the plaintiff of a plea of debt, or treſpaſs, &c. as the caſe may be. This writ, and all others ſubſequent to the original writ, not iſſuing out of chancery, but from the court into which the original was returnable, and being grounded on what has paſſed in that court in conſequence of the ſheriff's return, are called *judicial*, not *original*, writs; they iſſue under the private ſeal of that court, and not under the great ſeal of England; and are *teſted*, not in the king's name, but in that of the chief juſtice only. And theſe ſeveral writs being grounded on the ſheriff's return, muſt reſpectively bear date the ſame day on which the writ immediately preceding was returnable.

This is the regular and orderly method of proceſs. But it is now uſual in practice to ſue out the *capias* in the firſt inſtance, upon a ſuppoſed return of the ſheriff; eſpecially if it be ſuſpected that the defendant, upon notice of the action, will abſcond; and afterwards a fictitious original is drawn up, with a proper return thereupon, in order to give the proceedings a colour of regularity. When this *capias* is delivered to the ſheriff, he by his under-ſheriff grants a warrant to his inferior officers or bailiffs to execute it on the defendant. And, if the ſheriff of Oxfordſhire (in which county the injury is ſuppoſed to be committed and the action is laid) cannot find the defendant in his juriſdiction, he returns that he is not found, *non eſt inventus*, in his bailiwick: whereupon another writ iſſues, called a *teſtatum capias*, directed to the ſheriff of the county where the defendant is ſuppoſed to reſide, as of Berkſhire, reciting the former writ, and that it is teſtified, *teſtatum eſt*, that the defendant lurks or wanders in his bailiwick, where he is commanded to take him, as in the former *capias*. But here alſo, when the action is brought in one county and the defendant lives in another, it is uſual, for ſaving trouble, time, and expence, to make out a *teſtatum capias* at the firſt; ſuppoſing not only an original, but alſo a former *capias*, to have been granted; which in fact never was. And this fiction, being beneficial to all parties, is readily acquieſced in, and is now become the ſettled practice; being one among many inſtances to illuſtrate that maxim of law, that *in fictione juris conſiſtit æquitas*.

But where a defendant abſconds, and the plaintiff would proceed to an outlawry againſt him, an original writ muſt then be ſued out regularly, and after that a *capias*. And if the ſheriff cannot find the defendant upon the firſt writ of *capias*, and returns a *non eſt inventus*, there iſſues out an *alias* writ, and after that a *pluries*, to the ſame effect as the former: only after theſe words "we command you," this clauſe is inſerted, "as we have formerly," or, "as we have often commanded you;"—"*ſicut* alias," or, "*ſicut* pluries, *præcepimus*." And if a *non eſt inventus* is returned upon all of them, then a writ of *exigent* or *exigi facias* may be ſued out, which requires the ſheriff to cauſe the defendant to be proclaimed, required, or exacted, in five county-courts ſucceſſively, to render himſelf; and if he does, then to take him, as in a *capias*: but if he does not appear, and is returned *quinto exactus*, he ſhall then be outlawed by the coroners of the county. Alſo by ſtatute 6 Hen. VIII. c. 4. and 31 Eliz. c. 3. whether the defendant dwells within the ſame or another county than that wherein the *exigent* is ſued out, a *writ of proclamation* ſhall iſſue out at the ſame time with the *exigent*, commanding the ſheriff of the county, wherein the defendant dwells, to make three proclamations thereof in places the moſt notorious, and moſt likely to come to his knowledge, a month before the outlawry ſhall take place. Such outlawry is putting a man out of the protection of the law, ſo that he is incapable to bring an action for redreſs of injuries; and it is alſo attended with a forfeiture of all one's goods and chattels to the king. And therefore, till ſome time after the conqueſt, no man could be outlawed but for felony: but in Bracton's time, and ſomewhat earlier, proceſs of outlawry was ordained to lie in all actions for treſpaſſes *vi et armis*. And ſince, by a variety of ſtatutes (the ſame which allow the writ of *capias* before-mentioned) proceſs of outlawry doth lie in divers actions that are merely civil; providing they be commenced by original and not by bill. If after outlawry the defendant appears publicly, he may be arreſted by a writ of *capias utlagatum*, and committed till the outlawry be reverſed. Which reverſal may be had by the defendant's appearing perſonally in court (and in the king's bench without any perſonal appearance, ſo that he appears by attorney, according to ſtatute 4 & 5 W. & M. c. 18.) and any plauſible cauſe, however ſlight, will in general be ſufficient to reverſe it, it being conſidered only as a proceſs to compel an appearance. But then the defendant muſt pay full coſts, and put the plaintiff in the ſame condition as if he had appeared before the writ of *exigi facias* was awarded.

Proceſs.

Such is the firſt proceſs in the court of common pleas. In the king's bench they may alſo (and frequently do) proceed in certain cauſes, particularly in actions of ejectment and treſpaſs, by *original* writ, with *attachment* and *capias* thereon; returnable, not at Weſtminſter, where the common pleas are now fixed in conſequence of *magna charta*, but *ubicunque fuerimus in Anglia*, whereſoever the king ſhall then be in England; the king's bench being removeable into any part of England at the pleaſure and diſcretion of the crown. But the more uſual method of proceeding therein is without any original, but by a peculiar ſpecies of proceſs intitled a *bill of Middleſex*; and therefore ſo intitled, becauſe the court now ſits in that county; for if it ſat in Kent, it would then be a bill of Kent. For though, as the juſtices of this court have, by its fundamental conſtitution, power to determine all offences and treſpaſſes, by the common law and cuſtom of the realm, it needed no original writ from the crown to give it cognizance of any miſdemeſnor in the county wherein it reſides; yet as, by this court's coming into any county, it immediately ſuperſeded the ordinary adminiſtration of juſtice by the general commiſſions of *eyre* and of *oyer and terminer*, a proceſs of its own became neceſſary, within the county where

Proceſs. it ſat, to bring in ſuch perſons as were accuſed of committing any forcible injury. The bill of Middleſex (which was formerly always founded on a plaint of treſpaſs *quare clauſum fregit*, entered on the records of the court) is a kind of *capias*, directed to the ſheriff of that county, and commanding him to take the defendant, and have him before our lord the king at Weſtminſter on a day prefixed, to anſwer to the plaintiff of a plea of treſpaſs. For this accuſation of treſpaſs it is that gives the court of king's bench juriſdiction in other civil cauſes, ſince, when once the defendant is taken into cuſtody of the marſhal, or priſon-keeper of this court, for the ſuppoſed treſpaſs, he, being then a priſoner of this court, may here be proſecuted for any other ſpecies of injury. Yet, in order to found this juriſdiction, it is not neceſſary that the defendant be actually the marſhal's priſoner; for, as ſoon as he appears, or puts in bail, to the proceſs, he is deemed by ſo doing to be in ſuch cuſtody of the marſhal as will give the court a juriſdiction to proceed. And, upon theſe accounts, in the bill or proceſs, a complaint of treſpaſs is always ſuggeſted, whatever elſe may be the real cauſe of action. This bill of Middleſex muſt be ſerved on the defendant by the ſheriff, if he finds him in that county: but if he returns, *non eſt inventus*, then there iſſues out a writ of *latitat*, to the ſheriff of another county, as Berks; which is ſimilar to the *teſtatum capias* in the common pleas, and recites the bill of Middleſex and the proceedings thereon, and that it is teſtified that the defendant *latitat et diſcurrit*, lurks and wanders about in Berks; and therefore commands the ſheriff to take him, and have his body in court on the day of the return. But as in the common pleas the *teſtatum capias* may be ſued out upon only a ſuppoſed, and not an actual preceding, *capias*; ſo in the king's bench a *latitat* is uſually ſued out upon only a ſuppoſed, and not an actual, bill of Middleſex. So that, in fact, a *latitat* may be called the firſt proceſs in the court of king's bench, as the *teſtatum capias* is in the common pleas. Yet, as in the common pleas, if the defendant lives in the county wherein the action is laid, a common *capias* ſuffices; ſo in the king's bench likewiſe, if he lives in Middleſex, the proceſs muſt ſtill be by bill of Middleſex only.

In the exchequer the firſt proceſs is by writ of *quo minus*, in order to give the court a juriſdiction over pleas between party and party. In which writ the plaintiff is alleged to be the king's farmer or debtor, and that the defendant hath done him the injury complained of, *quo minus ſufficiens exiſtit*, by which he is the leſs able to pay the king his rent or debt. And upon this the defendant may be arreſted as upon a *capias* from the common pleas.

Thus differently do the three courts ſet out at firſt, in the commencement of a ſuit, in order to intitle the two courts of king's bench and exchequer to hold plea in ſubjects cauſes, which by the original conſtitution of Weſtminſter-hall they were not empowered to do. Afterwards, when the cauſe is once drawn into the reſpective courts, the method of purſuing it is pretty much the ſame in all of them.

If the ſheriff had found the defendant upon any of the former writs, the *capias latitat*, &c. he was anciently obliged to take him into cuſtody, in order to produce him in court upon the return, however ſmall and minute the cauſe of action might be. For, not having obeyed the original ſummons, he had ſhown a contempt of the court, and was no longer to be truſted at large. But when the ſummons fell into diſuſe, and the *capias* became in fact the firſt proceſs, it was thought hard to impriſon a man for a contempt which was only ſuppoſed: and therefore, in common caſes, by the gradual indulgence of the courts (at length authoriſed by ſtatute 12 Geo. I. c. 29. which was amended by ſtatute 5 Geo. II. c. 27. and made perpetual by ſtatute 21 Geo. II. c. 3.) the ſheriff or his officer can now only perſonally ſerve the defendant with the copy of the writ or proceſs, and with notice in writing to appear by his attorney in court to defend this action; which in effect reduces it to a mere ſummons. And if the defendant thinks proper to appear upon this notice, his appearance is recorded, and he puts in ſureties for his future attendance and obedience; which ſureties are called *common bail*, being the ſame two imaginary perſons that were pledges for the plaintiff's proſecution, John Doe and Richard Roe. Or, if the defendant does not appear upon the return of the writ, or within four (or in ſome caſes eight) days after, the plaintiff may enter an appearance for him, as if he had really appeared; and may file common bail in the defendant's name, and proceed thereupon as if the defendant had done it himſelf.

But if the plaintiff will make affidavit, or aſſert upon oath, that the cauſe of action amounts to ten pounds or upwards, then in order to arreſt the defendant, and make him put in ſubſtantial ſureties for his appearance, called *ſpecial bail*, it is required by ſtatute 13 Car. II. ſtat. 2. c. 2. that the true cauſe of action ſhould be expreſſed in the body of the writ or proceſs: elſe no ſecurity can be taken in a greater ſum than L. 40. This ſtatute (without any ſuch intention in the makers) had like to have ouſted the king's bench of all its juriſdiction over civil injuries without force: for, as the bill of Middleſex was framed only for actions of treſpaſs, a defendant could not be arreſted and held to bail thereupon for breaches of civil contracts. But to remedy this inconvenience, the officers of the king's bench deviſed a method of adding what is called a clauſe of *ac etiam* to the uſual complaint of treſpaſs; the bill of Middleſex commanding the defendant to be brought in to anſwer the plaintiff of a plea of treſpaſs, *and alſo* to a bill of debt: the complaint of treſpaſs giving cognizance to the court, and that of debt authoriſing the arreſt. In imitation of which, lord chief juſtice North, a few years afterwards, in order to ſave the ſuitors of his court the trouble and expence of ſuing out ſpecial originals, directed, that in the common pleas, beſides the uſual complaint of breaking the plaintiff's cloſe, a clauſe of *ac etiam* might be alſo added to the writ of *capias*, containing the true cauſe of action; as, "that the ſaid Charles the defendant may anſwer to the plaintiff of a plea of treſpaſs in breaking his cloſe: and alſo, *ac etiam* may anſwer him, according to the cuſtom of the court, in a certain plea of treſpaſs upon the caſe, upon promiſes, to the value of L. 20, &c." The ſum ſworn to by the plaintiff is marked upon the back of the writ; and the ſheriff, or his officer the bailiff, is then obliged actually to arreſt or take into cuſtody the body of the defendant, and, having ſo done, to return the writ with a *cepi corpus* indorſed thereon. See ARREST.

When the defendant is regularly arreſted, he muſt either

Proceſs. either go to priſon, for ſafe cuſtody; or put in *ſpecial bail* to the ſheriff. For, the intent of the arreſt being only to compel an appearance in court at the return of the writ, that purpoſe is equally anſwered, whether the ſheriff detains his perſon, or takes ſufficient ſecurity for his appearance, called *bail* (from the French word *bailler*, "to deliver)," becauſe the defendant is bailed, or delivered, to his ſureties, upon their giving ſecurity for his appearance; and is ſuppoſed to continue in their friendly cuſtody inſtead of going to gaol. See BAIL. The method of putting in bail to the ſheriff is by entering into a bond or obligation, with one or more ſureties, (not fictitious perſons, as in the former caſe of common bail, but real, ſubſtantial, reſponſible bondſmen), to inſure the defendant's appearance at the return of the writ; which obligation is called the *bail-bond*. The ſheriff, if he pleaſes, *may* let the defendant go without any ſureties; but that is at his own peril: for, after once taking him, the ſheriff is bound to keep him ſafely, ſo as to be forthcoming in court; otherwiſe an action lies againſt him for an eſcape. But, on the other hand, he is obliged, by ſtatute 23 Hen. VI. c. 10. to take (if it be tendered) a ſufficient bail-bond; and, by ſtatute 12 Geo. I. c. 29. the ſheriff ſhall take bail for no other ſum than ſuch as is ſworn to by the plaintiff, and indorſed on the back of the writ.

Upon the return of the writ, or within four days after, the defendant muſt *appear* according to the exigency of the writ. This *appearance* is effected by putting in and juſtifying bail *to the action*; which is commonly called *putting in bail above*. If this be not done, and the bail that were taken by the ſheriff *below* are reſponſible perſons, the plaintiff may take an aſſignment from the ſheriff of the bail-bond (under the ſtatute 4 & 5 Ann. c. 16.) and bring an action thereupon againſt the ſheriff's bail. But if the bail ſo accepted by the ſheriff be inſolvent perſons, the plaintiff may proceed againſt the ſheriff himſelf, by calling upon him, firſt to return the writ (if not already done), and afterwards to bring in the body of the defendant. And if the ſheriff does not then cauſe ſufficient bail to be put in *above*, he will himſelf be reſponſible to the plaintiff.

The bail *above*, or bail *to the action*, muſt be put in either in open court, or before one of the judges thereof; or elſe, in the country, before a commiſſioner appointed for that purpoſe by virtue of the ſtatute 4 W. & M. c. 4. which muſt be tranſmitted to the court. Theſe bail, who muſt at leaſt be two in number, muſt enter into a recognizance in court, or before the judge or commiſſioner, whereby they do jointly and ſeverally undertake, that if the defendant be condemned in the action, he ſhall pay the coſts and condemnation, or render himſelf a priſoner, or that they will pay it for him: which recognizance is tranſmitted to the court in a ſlip of parchment, intitled a *bail-piece*. And, if required, the bail muſt *juſtify* themſelves in court, or before the commiſſioner in the country, by ſwearing themſelves houſekeepers, and each of them to be worth double the ſum for which they are bail, after payment of all their debts. This anſwers in ſome meaſure to the *ſtipulatio* or *ſatiſdatio* of the Roman laws, which is mutually given by each litigant party to the other: by the plaintiff that he will proſecute his ſuit, and pay the coſts if he loſes his cauſe; in like manner as our law ſtill requires nominal pledges of proſecution from the plaintiff: by the defendant, that he ſhall continue in court, and abide the ſentence of the judge, much like our ſpecial bail; but with this difference, that the *fidejuſſores* were there abſolutely bound *judicatum ſolvere*, to ſee the coſts and condemnation paid at all events: whereas our ſpecial bail may be diſcharged, by ſurrendering the defendant into cuſtody within the time allowed by law; for which purpoſe they are at all times intitled to a warrant to apprehend him. Proceſs.

Special bail is required (as of courſe) only upon actions of debt, or actions on the caſe in trover, or for money due, where the plaintiff can ſwear that the cauſe of action amounts to ten pounds: but in actions where the damages are precarious, being to be aſſeſſed *ad libitum* by a jury, as in actions for words, ejectment, or treſpaſs, it is very ſeldom poſſible for a plaintiff to ſwear to the amount of his cauſe of action; and therefore no ſpecial bail is taken thereon, unleſs by a judge's order, or the particular directions of the court, in ſome peculiar ſpecies of injuries, as in caſes of mayhem or atrocious battery; or upon ſuch ſpecial circumſtances as make it abſolutely neceſſary that the defendant ſhould be kept within the reach of juſtice. Alſo in actions againſt heirs, executors, and adminiſtrators, for debts of the deceaſed, ſpecial bail is not demandable; for the action is not ſo properly againſt them in perſon, as againſt the effects of the deceaſed in their poſſeſſion. But ſpecial bail is required even of them, in actions for a *devaſtavit*, or waſting the goods of the deceaſed; that wrong being of their own committing.

Thus much for *proceſs*; which is only meant to bring the defendant into court, in order to conteſt the ſuit, and abide the determination of the law. When he appears either in perſon as a priſoner, or out upon bail, then follow the *pleadings* between the parties. See PLEADINGS.

PROCESS upon an Indictment. See PROSECUTION. The proper proceſs on an indictment for any petty miſdemeſnor, or on a penal ſtatute, is a writ of *venire facias*, which is in the nature of a ſummons to cauſe the party to appear. And if by the return to ſuch *venire* it appears that the party hath lands in the county whereby he may be diſtrained, then a *diſtreſs infinite* ſhall be iſſued from time to time till he appears. But if the ſheriff returns, that he hath no lands in his bailiwick, then (upon his non-appearance) a writ of *capias* ſhall iſſue, which commands the ſheriff to take his body, and have him at the next aſſiſes; and if he cannot be taken upon the firſt *capias*, a ſecond and a third ſhall iſſue, called an *alias*, and a *pluries capias*. But, on indictments for treaſon or felony, a *capias* is the firſt proceſs: and, for treaſon or homicide, only one ſhall be allowed to iſſue, or two in the caſe of other felonies, by ſtatute 25 Edw. III. c. 14. though the uſage is to iſſue only one in any felony; the proviſions of this ſtatute being in moſt caſes found impracticable. And ſo, in the caſe of miſdemeſnors, it is now the uſual practice for any judge of the court of king's bench, upon certificate of an indictment found, to award a writ of *capias* immediately, in order to bring in the defendant. But if he abſconds, and it is thought proper to purſue him to an outlawry, then a greater exactneſs is neceſſary. For, in ſuch caſe, after the ſeveral writs have iſſued in a regular number, according to the nature of the reſpective

Proceſs. ſpective crimes, without any effect, the offender ſhall be put in the *exigent* in order to his outlawry: that is, he ſhall be exacted, proclaimed, or required, to ſurrender, at five county-courts; and if he be returned *quinto exactus*, and does not appear at the fifth exaction or requiſition, then he is adjudged to be *outlawed*, or put out of the protection of the law; ſo that he is incapable of taking the benefit of it in any reſpect, either by bringing actions or otherwiſe.

The puniſhment, for outlawries upon indictments for miſdemeſnors, is the ſame as for outlawries upon civil actions; viz. forfeiture of goods and chattels. But an outlawry in treaſon or felony amounts to a conviction and attainder of the offence charged in the indictment, as much as if the offender had been found guilty by his country. His life is, however, ſtill under the protection of the law, as hath elſewhere been obſerved; (ſee HOMICIDE): that though anciently an outlawed felon was ſaid to have *caput lupinum*, and might be knocked on the head like a wolf, by any one that ſhould meet him; becauſe, having renounced all law, he was to be dealt with as in a ſtate of nature, when every one that ſhould find him might ſlay him: yet now, to avoid ſuch inhumanity, it is holden that no man is intitled to kill him wantonly or wilfully; but in ſo doing is guilty of murder, unleſs it happens in the endeavour to apprehend him. For any perſon may arreſt an outlaw on a criminal proſecution, either of his own head, or by writ or warrant of *capias utlagatum*, in order to bring him to execution. But ſuch outlawry may be frequently reverſed by writ of error, the proceedings therein being (as it is fit they ſhould be) exceedingly nice and circumſtantial; and if any ſingle minute point be omitted or miſconducted, the whole outlawry is illegal, and may be reverſed: upon which reverſal the party accuſed is admitted to plead to, and defend himſelf againſt, the indictment.

Thus much for proceſs to bring in the offender after indictment found; during which ſtage of the proſecution it is that writs of *certiorari facias* are uſually had, though they may be had at any time before trial, to certify and remove the indictment, with all the proceedings thereon, from any inferior court of criminal juriſdiction into the court of king's bench; which is the ſovereign ordinary court of juſtice in cauſes criminal. And this is frequently done for one of theſe four purpoſes; either, 1. To conſider and determine the validity of appeals or indictments and the proceedings thereon; and to quaſh or confirm them as there is cauſe; or, 2. Where it is ſurmiſed that a partial or inſufficient trial will probably be had in the court below, the indictment is removed, in order to have the priſoner or defendant tried at the bar of the court of king's bench, or before the juſtices of *niſi prius*: or, 3. It is ſo removed, in order to plead the king's pardon there: or, 4. To iſſue proceſs of outlawry againſt the offender, in thoſe counties or places where the proceſs of the inferior judges will not reach him. Such writ of *certiorari*, when iſſued and delivered to the inferior court for removing any record or other proceeding, as well upon indictment as otherwiſe, ſuperſedes the juriſdiction of ſuch inferior court, and makes all ſubſequent proceedings therein entirely erroneous and illegal; unleſs the court of king's bench remands the record to the court below, to be there tried and determined. A *certiorari* may be granted at the inſtance of either the proſecutor or the defendant: the former as a matter of right, the latter as a matter of diſcretion; and therefore it is ſeldom granted to remove indictments from the juſtices of gaol-delivery, or after iſſue joined, or confeſſion of the fact in any of the courts below. Proceſs || Proclamation.

At this ſtage of proſecution alſo it is, that indictments found by the grand jury againſt a peer, muſt, in conſequence of a writ of *certiorari*, be certified and tranſmitted into the court of parliament, or into that of the lord high ſteward of Great Britain; and that, in places of excluſive juriſdiction, as the two univerſities, indictments muſt be delivered (upon challenge and claim of cognizance) to the courts therein eſtabliſhed by charter, and confirmed by act of parliament, to be there reſpectively tried and determined. See PLEA.

PROCESS, in chemiſtry, the whole courſe of an experiment or ſeries of operations, tending to produce ſomething new.

PROCESS, in anatomy, denotes any protuberance or eminence in a bone.

PROCESSION, a ceremony in the Romiſh church, conſiſting of a formal march of the clergy and people, putting up prayers, &c. and in this manner viſiting ſome church, &c. They have alſo proceſſions of the hoſt or ſacrament, &c. See HOST.

PROCHEIN AMY, in law, the perſon next akin to a child in non-age, and who, in that reſpect, is allowed to act for him, and be his guardian, &c. if he hold land in ſoccage.

To ſue, an infant is not allowed to make an attorney; but the court will admit his next friend as plaintiff, or his guardian as defendant.

PROCKIA, in botany: A genus of the monogynia order, belonging to the polyandria claſs of plants; and in the natural method ranking with thoſe of which the order is doubtful. The calyx is triphyllous, beſides two leafets at the baſe. There is no corolla; the berry is quinqueangular, and polyſpermous.

PROCLAMATION, a public notice given of any thing of which the king thinks proper to adverti ſe his ſubjects.

Proclamations are a branch of the king's prerogative *; and have then a binding force, when (as Sir Edward Coke obſerves) they are grounded upon and enforce the laws of the realm. For, though the making of laws is entirely the work of a diſtinct part, the legiſlative branch of the ſovereign power, yet the manner, time, and circumſtances of putting thoſe laws in execution, muſt frequently be left to the diſcretion of the executive magiſtrate. And therefore his conſtitutions or edicts, concerning thoſe points which we call *proclamations*, are binding upon the ſubject, where they do not either contradict the old laws, or tend to eſtabliſh new ones; but only enforce the execution of ſuch laws as are already in being, in ſuch manner as the king ſhall judge neceſſary. Thus the eſtabliſhed law is, that the king may prohibit any of his ſubjects from leaving the realm: a proclamation therefore forbidding this in general for three weeks, by laying an embargo upon all ſhipping in time of war, will be equally binding as an act of parliament, becauſe founded upon a prior law. But a proclamation to lay an embargo in time of peace upon all veſſels laden with wheat, (though in the time of a public ſcarcity), being contrary to law, * See Prerogative.

Proclus || Prodigality.

and particularly to ſtatute 22 Car. II. c. 13. the adviſers of ſuch a proclamation, and all perſons acting under it, found it neceſſary to be indemnified by a ſpecial act of parliament, 7 Geo. III. c. 7. A proclamation for diſarming Papiſts is alſo binding, being only in execution of what the legiſlature has firſt ordained: but a proclamation for allowing arms to Papiſts, or for diſarming any Proteſtant ſubjects, will not bind; becauſe the firſt would be to aſſume a diſpenſing power, the latter a legiſlative one; to the veſting of either of which in any ſingle perſon the laws of England are abſolutely ſtrangers. Indeed, by the ſtatute 31 Hen. VIII. c. 8. it was enacted, that the king's proclamations ſhould have the force of acts of parliament: a ſtatute, which was calculated to introduce the moſt deſpotic tyranny; and which muſt have proved fatal to the liberties of this kingdom, had it not been luckily repealed in the minority of his ſucceſſor, about five years after. By a late act of parliament the king is empowered to raiſe regiments of Roman Catholics, to ſerve in the preſent war.

PROCLUS, ſurnamed DIADOCUS, a Greek philoſopher and mathematician, was born in Lycia, and lived about the year 500. He was the diſciple of Syrianus, and had a great ſhare in the friendſhip of the emperor Anaſtaſius. It is ſaid, that when Vitalian laid ſiege to Conſtantinople, Proclus burnt his ſhips with large brazen ſpeculums. This philoſopher was a Pagan, and wrote againſt the Chriſtian religion. There are ſtill extant his Commentaries on ſome of Plato's books, and other of his works written in Greek.

PROCONSUL, a Roman magiſtrate, ſent to govern a province with conſular authority.

The proconſuls were appointed out of the body of the ſenate; and uſually as the year of any one's conſulate expired, he was ſent proconſul into ſome province.

The proconſuls decided caſes of equity and juſtice, either privately in their pretorium or palace, where they received petitions, heard complaints, granted writs under their ſeal, and the like; or elſe publicly, in the common hall, with the uſual formalities obſerved in the court of judicature at Rome. They had beſides, by virtue of their edicts, the power of ordering all things relating to the tribunes, taxes, contributions, and proviſions of corn and money, &c. Their office laſted only a year. See CONSUL.

PROCOPIUS, a famous Greek hiſtorian, born in Cæſaria, acquired great reputation by his works in the reign of Juſtinian, and was ſecretary to Beliſarius during all the wars carried on by that general in Perſia, Africa, and Italy. He at length became ſenator, obtained the title of *illuſtrious*, and was made pretor of Conſtantinople.

PROCREATION, the begetting and bringing forth young. See GENERATION and SEMEN.

PROCTOR, a perſon commiſſioned to manage another perſon's cauſe in any court of the civil or eccleſiaſtical law.

PROCTOR, in the Engliſh univerſities. See UNIVERSITY.

PROCURATION, an act or inſtrument by which a perſon is empowered to treat, tranſact, receive, &c. in another perſon's name.

PROCURATOR. See PROCTOR.

PRODIGALITY, means extravagance, profuſion, waſte, or exceſſive liberality, and is the oppoſite extreme to the vice of parſimony. By the Roman law, if a man by notorious prodigality was in danger of waſting his eſtate, he was looked upon as *non compos*, and committed to the care of curators, or tutors, by the prætor. And by the laws of Solon, ſuch prodigals were branded with perpetual infamy.

Product || Prognoſtic.

PRODUCT, in arithmetic and geometry, the factum of two or more numbers, or lines, &c. into one another: thus $5 \times 4 = 20$ the product required.

PROEDRI, among the Athenians, were magiſtrates, who had the firſt ſeats at the public aſſemblies, and whoſe office it was to propoſe at each aſſembly the things to be deliberated upon and determined. Their office always ended with the meeting. Their number was nine, ſo long as the tribes were ten in number.

PROFANATION, the acting diſreſpectfully to ſacred things.

PROFANE. a term uſed in oppoſition to *holy*; and in general is applied to all perſons who have not the ſacred character, and to things which do not belong to the ſervice of religion.

PROFESSION means a calling, vocation, or known employment. In Knox's *Eſſays*, vol. 1ſt, page 234, we find an excellent paper on the choice of a profeſſion, which that elegant writer concludes thus: "All the occupations of life (ſays he) are found to have their advantages and diſadvantages admirably adapted to preſerve the juſt equilibrium of happineſs. This we may confidently aſſert, that, whatever are the inconveniences of any of them, they are all preferable to a life of inaction; to that wretched liſtleſſneſs, which is conſtrained to purſue pleaſure as a buſineſs, and by rendering it the object of ſevere and unvaried attention, deſtroys its very eſſence."

Among the Romaniſts profeſſion denotes the entering into a religious order, whereby a perſon offers himſelf to God by a vow of inviolably obſerving obedience, chaſtity, and poverty.

PROFESSOR, in the univerſities, a perſon who teaches or reads public lectures in ſome art or ſcience from a chair for the purpoſe.

PROFILE, in architecture, the draught of a building, fortification, &c. wherein are expreſſed the ſeveral heights, widths, and thickneſſes, ſuch as they would appear were the building cut down perpendicularly from the roof to the foundation. Whence the profile is alſo called the *ſection*, ſometimes *orthographical ſection*, and by Vitruvius alſo *ſciagraphy*.

Profile, in this ſenſe, amounts to the ſame with *elevation*; and ſtands oppoſed to a *plan* or *ichnography*.

PROFILE is alſo uſed for the contour or out-line of a figure, building, member of architecture, or the like; as a baſe, a cornice, &c. Hence *profiling* is ſometimes uſed for deſigning, or deſcribing the member with rule, compaſs, &c.

PROFILE, in ſculpture and painting.—A head, a portrait, &c. are ſaid to be in *profile*, when they are repreſented ſidewiſe, or in a ſide-view; as, when in a portrait there is but one ſide of the face, one eye, one cheek, &c. ſhown, and nothing of the other.—On almoſt all medals, the faces are repreſented in *profile*.

PROFLUVIUM, in medicine, denotes a flux, or liquid evacuation of any thing.

PROGNOSTIC, among phyſicians, ſignifies a judgement concerning the event of a diſeaſe, as whether it ſhall end in life or death, be ſhort or long, mild or malignant, &c.

PROGRAMMA,

Programma. PROGRAMMA, anciently ſignified a letter ſealed with the king's ſeal.

Programma is alſo an univerſity term for a billet or adverti ſement, poſted up or given into the hand, by way of invitation to an oration, &c. containing the argument, or ſo much as is neceſſary for underſtanding thereof.

Progreſſion. PROGRESSION, in general, denotes a regular advancing, or going forward, in the ſame courſe and manner.

PROGRESSION, in mathematics, is either arithmetical or geometrical. Continued arithmetic proportion is, where the terms do increaſe and decreaſe by equal differences, and is called *arithmetic progreſſion*:

$$\text{Thus } \left\{\begin{array}{l} a,\ a+d,\ a+2d,\ a+3d, \text{ \&c. increaſing} \\ a,\ a-d,\ a-2d,\ a-3d, \text{ \&c. decreaſing} \end{array}\right\} \text{ by the difference } d.$$

$$\text{In numbers } \left\{\begin{array}{l} 2,\ 4,\ 6,\ 8,\ 10, \text{ \&c. increaſing} \\ 10,\ 8,\ 6,\ 4,\ 2, \text{ \&c. decreaſing} \end{array}\right\} \text{ by the difference 2.}$$

Geometric Progreſſion, or *Continued Geometric Proportion*, is when the terms do increaſe or decreaſe by equal ratios: thus,

$$\left.\begin{array}{l} a,\ ar,\ arr,\ arrr, \text{ \&c. increaſing} \\ a,\ \frac{a}{r},\ \frac{a}{rr},\ \frac{a}{rrr}, \text{ \&c. decreaſing} \end{array}\right\} \text{ from a continual } \left\{\begin{array}{l} \text{multiplication} \\ \text{diviſion} \end{array}\right\} \text{ by } r.$$

$$\left.\begin{array}{r} 2,\ 4,\ 8,\ 16,\ 32,\ 64, \text{ increaſing} \\ 64,\ 32,\ 16,\ 8,\ 4,\ 2, \text{ decreaſing} \end{array}\right\} \text{ from a continual } \left\{\begin{array}{l} \text{multiplication} \\ \text{diviſion} \end{array}\right\} \text{ by } 2.$$

See the articles FLUXIONS, GEOMETRY, and SERIES.

PROJECTILES.

1 Object of the ſcience. THIS is the name for that part of mechanical philoſophy which treats of the motion of bodies any how projected from the ſurface of this earth, and influenced by the action of terreſtrial gravity.

2 Effect of gravity in projected bodies, It is demonſtrated in the phyſical part of aſtronomy that a body ſo projected muſt deſcribe a conic ſection, having the centre of the earth in one focus; and that it will deſcribe round that focus areas proportional to the times. And it follows from the principles of that ſcience, that if the velocity of projection exceeds 36700 feet in a ſecond, the body (if not reſiſted by the air) would deſcribe a hyperbola; if it be juſt 36700, it would deſcribe a parabola; and if it be leſs than this, it would deſcribe an ellipſis. If projected directly upwards, in the firſt caſe, it would never return, but proceed for ever; its velocity continually diminiſhing, but never becoming leſs than an aſſignable portion of the exceſs of the initial velocity above 36700 feet in a ſecond; in the ſecond caſe, it would never return, its velocity would diminiſh without end, but never be extinguiſhed. In the third caſe, it would proceed till its velocity was reduced to an aſſignable portion of the difference between 36700 and its initial velocity; and would then return, regaining its velocity by the ſame degrees, and in the ſame places, as it loſt it. Theſe are neceſſary conſequences of a gravity directed to the centre of the earth, and inverſely proportional to the ſquare of the diſtance. But in the greateſt projections that we are able to make, the gravitations are ſo nearly equal, and in directions ſo nearly parallel, that it would be ridiculous affectation to pay any regard to the deviations from equality and parallelism. A bullet riſing a mile above the ſurface of the earth loſes only $\frac{1}{1000}$ of its weight, and a horizontal range of 4 miles makes only 4′ of deviation from parallelism.

Let us therefore aſſume gravitation as equal and parallel. The errors ariſing from this aſſumption are quite inſenſible in all the uſes which can be made of this theory.

The theory itſelf will ever be regarded with ſome veneration and affection by the learned. It was the firſt fruits of mathematical philoſophy. Galileo was the firſt who applied mathematical knowledge to the motions of free bodies, and this was the ſubject on which he exerciſed his fine genius.

3 Conſtant or uniform. Gravity muſt be conſidered by us as a conſtant or uniform accelerating or retarding force, according as it produces the deſcent, or retards the aſcent, of a body. A conſtant or invariable accelerating force is one which produces an uniform acceleration; that is, which in equal times produces equal increments of velocity, and therefore produces increments of velocity proportional to the times in which they are produced. Forces are of themſelves imperceptible, and are ſeen only in their effects; and they have no meaſure but the effect, or what *meaſures* the effect; and every thing which we can diſcover with regard to thoſe meaſures, we muſt affirm with regard to the things of which we aſſume them as the meaſures. Therefore,

4 Conſequences of this fact. The motion of a falling body, or of a body projected directly downwards, is uniformly accelerated; and that of a body projected directly upwards is uniformly retarded: that is, the acquired velocities are as the times in which they are acquired by falling, and the extinguiſhed velocities are as the times in which they are extinguiſhed.

5 Corollaries drawn from it. *Cor.* 1. If bodies ſimply fall, not being projected downwards by any external force, the times of the falls are proportional to the final velocities; and the times of aſcents, which terminate by the action of gravity alone, are proportional to the initial velocities.

2. The ſpaces deſcribed by a heavy body falling from reſt are as the ſquares of the acquired velocities; and the differences of theſe ſpaces are as the differences of the ſquares of the acquired velocities: and, on the other hand, the heights to which bodies projected upwards will riſe, before their motions be extinguiſhed, are as the ſquares of the initial velocities.

3. The ſpaces deſcribed by falling bodies are proportional to the ſquares of the times from the beginning of the fall; and the ſpaces deſcribed by bodies projected directly upwards are as the ſquares of the times of the aſcents.

4. The ſpace deſcribed by a body falling from reſt is one half of the ſpace which the body would have uniformly deſcribed in the ſame time, with the velocity ac-

quired by the fall.—And the height to which a body will riſe, in oppoſition to the action of gravity, is one half of the ſpace which it would uniformly deſcribe in the ſame time with the initial velocity.

In like manner the difference of the ſpaces which a falling or riſing body deſcribes in any equal ſucceſſive parts of its fall or riſe, is one half of the ſpace which it would uniformly deſcribe in the ſame time with the difference of the initial and final velocities.

This propoſition will be more conveniently expreſſed for our purpoſe thus:

A body moving uniformly during the time of any fall with the velocity acquired thereby, will in that time deſcribe a ſpace double of that fall; and a body projected directly upwards will riſe to a height which is one half of the ſpace which it would, uniformly continued, deſcribe in the time of its aſcent with the initial velocity of projection.

Theſe theorems have been already demonſtrated in a popular way, in the article MECHANICS, ſect. vi. § 14, 15, 16, &c. and in GUNNERY. But we would recommend to our readers the 39th prop. of the firſt book of Newton's *Principia*, as giving the moſt general inveſtigation of this ſubject; equally eaſy with theſe more looſe methods of demonſtration, and infinitely ſuperior to them, by being equally applicable to every variation of the accelerating force. See an excellent application of this propoſition by Mr Robins, for defining the motion of a ball diſcharged from a cannon, in the article GUNNERY, n° 15. See another in OPTICS, n° 127. for defining the motion of light in refraction, &c.

6 The force of gravity in falling bodies can be aſcertained.

5. It is a matter of obſervation and experience, that a heavy body falls 16 feet and an inch Engliſh meaſure in a ſecond of time; and therefore acquires the velocity of 32 feet 2 inches *per* ſecond. This cannot be aſcertained directly, with the preciſion that is neceſſary. A ſecond is too ſmall a portion of time to be exactly meaſured and compared with the ſpace deſcribed; but it is done with the greateſt accuracy by comparing the motion of a falling body with that of a pendulum. The time of a vibration is to the time of falling through half the length of the pendulum, as the circumference of a circle is to its diameter. The length of a pendulum can be aſcertained with great preciſion; and it can be lengthened or ſhortened till it makes juſt 86,400 vibrations in a day: and this is the way in which the ſpace fallen through in a ſecond has been accurately aſcertained.

As all other forces are aſcertained by the accelerations which they produce, they are conveniently meaſured by comparing their accelerations with the acceleration of gravity. This therefore has been aſſumed by all the later and beſt writers on mechanical philoſophy, as the unit by which every other force is meaſured. It gives us a perfectly diſtinct notion of the force which retains the moon in its orbit, when we ſay it is the 3600th part of the weight of the moon at the ſurface of the earth. We mean by this, that if a bullet were here weighed by a ſpring ſteel-yard, and pulled it out to the mark 3600; if it were then taken to the diſtance of the moon, it would pull it out only to the mark 1. And we make this aſſertion on the authority of our having obſerved that a body at the diſtance of the moon falls from that diſtance $\frac{1}{3600}$ part of 16 feet in a ſecond. We do not, therefore, compare the *forces*, which are imperceptible things; we compare the accelerations, which are their indications, effects, and meaſures.

7 Two modes of determining the fall of heavy bodies.

This has made philoſophers ſo anxious to determine with preciſion the fall of heavy bodies, in order to have an exact value of the accelerating power of terreſtrial gravity. Now we muſt here obſerve, that this meaſure may be taken in two ways: we may take the ſpace through which the heavy body falls in a ſecond; or we may take the velocity which it acquires in conſequence of gravity having acted on it during a ſecond. The laſt is the proper meaſure; for the laſt is the immediate effect on the body. The action of gravity has changed the ſtate of the body—in what way? by giving it a determination to motion downward: this both points out the kind and the degree or intenſity of the force of gravity. The ſpace deſcribed in a ſecond by falling, is not an invariable meaſure; for, in the ſucceſſive ſeconds, the body falls through 16, 48, 80, 112, &c. feet, but the changes of the bodies ſtate in each ſecond is the ſame. At the beginning it had no determination to move with any appreciable velocity; at the end of the firſt ſecond it had a determination by which it would have gone on for ever (had no ſubſequent force acted on it) at the rate of 32 feet *per* ſecond. At the end of the ſecond ſecond, it had a determination by which it would have moved for ever, at the rate of 64 feet *per* ſecond. At the end of the third ſecond, it had a determination by which it would have moved for ever, at the rate of 96 feet *per* ſecond, &c. &c. The difference of theſe determinations is a determination to the rate of 32 feet *per* ſecond. This is therefore conſtant, and the indication and proper meaſure of the conſtant or invariable force of gravity. The ſpace fallen through in the firſt ſecond is of uſe only as it is one half of the meaſure of this determination; and as halves have the proportion of their wholes, different accelerating forces may be ſafely affirmed to be in the proportion of the ſpaces through which they uniformly impel bodies in the ſame time. But we ſhould always recollect, that this is but one half of the true meaſure of the accelerating force. Mathematicians of the firſt rank have committed great miſtakes by not attending to this; and it is neceſſary to notice it juſt now, becauſe caſes will occur in the proſecution of this ſubject, where we ſhall be very apt to confound our reaſonings by a confuſion in the uſe of thoſe meaſures. Thoſe mathematicians who are accuſtomed to the geometrical conſideration of curvilineal motions, are generally diſpoſed to take the *actual deflection* from the tangent as the meaſure of the deflecting force; while thoſe who treat the ſame ſubject algebraically, by the aſſiſtance of fluxions, take *the change of velocity*, which is meaſured by *twice* the deflection. The reaſon is this: when a body paſſes through the point B of a curve ABC, fig. 1. if the deflecting force were to ceaſe at that inſtant, the body would deſcribe the tangent BD in the ſame time in which it deſcribes the arch BC of the curve, and DC is the deflection, and is therefore taken for the meaſure of the deflecting force. But the algebraiſt is accuſtomed to conſider the curve by means of an equation between the abſciſſæ H*a*, H*b*, H*c*, and their reſpective ordinates A*a*, B*b*, C*c*; and he meaſures the deflections by the changes made on the increments of the ordinates. Thus the increment of the ordinate A*a*, while the body deſcribes the arch AB of the curve, is BG. If the deflecting force were to ceaſe

8 Miſtakes of mathematicians on this ſubject;

Plate CCCCXVII.

ceaſe when the body is at B, the next increment would have been equal to BG, that is, it would have been EF; but, in conſequence of the deflection, it is only CF: therefore he takes EC for the meaſure of the deflection, and of the deflecting force. Now EC is ultimately twice DC; and thus the meaſure of the algebraiſt (derived ſolely from the nature of the differential method, and without any regard to phyſical conſiderations) happens to coincide with the true phyſical meaſure. There is therefore great danger of mixing theſe meaſures. Of this we cannot give a more remarkable inſtance than Leibnitz's attempt to demonſtrate the elliptical motion of the planets in the Leipſic Acts, 1689. He firſt conſiders the ſubject mechanically, and takes the deflection or DC for the meaſure of the deflecting force. He then introduces his differential calculus, where he takes the difference of the increments for the meaſure; and thus brings himſelf into a confuſion, which luckily compenſates for the falſe reaſoning in the preceding part of his paper, and gives his reſult the appearance of a demonſtration of Newton's great diſcovery, while, in fact, it is a confuſed jumble of aſſumptions, ſelf-contradictory, and inconſiſtent with the very laws of mechanics which are uſed by him in the inveſtigation. Seventeen years after this, in 1706, having been criticiſed for his bad reaſoning, or rather accuſed of an envious and unſucceſsful attempt to appropriate Newton's inventions to himſelf, he gives a correction of his paralogiſm, which he calls a correction of language. But he either had not obſerved where the paralogiſm lay, or would not let himſelf down by acknowledging a miſtake in what he wiſhed the world to think his own calculus (fluxions); he applied the correction where no fault had been committed, for he had meaſured both the centrifugal force and the ſolicitation of gravity in the ſame way, but had applied the fluxionary expreſſion to the laſt and not to the firſt, and, by ſo doing, he completely deſtroyed all coincidence between his reſult and the planetary motions. We mention this inſtance, not only as a caution to our mathematical readers, but alſo as a very curious literary anecdote. This diſſertation of Leibnitz is one of the moſt obſcure of his obſcure writings, but deſerves the attention of an intelligent and curious reader, and cannot fail of making an indelible impreſſion on his mind, with relation to the modeſty, candour, and probity of the author. It is preceded by a diſſertation on the ſubject which we are now entering upon, the motion of projectiles in a reſiſting medium. Newton's *Principia* had been publiſhed a few years before, and had been reviewed, in a manner ſhamefully ſlight, in the Leipſic Acts. Both theſe ſubjects make the capital articles of that immortal work. Mr Leibnitz publiſhed theſe diſſertations, without (ſays he) having ſeen Newton's book, in order to ſhow the world that he had, ſome years before, diſcovered the ſame theorems. Mr Nicholas Fatio carried a copy of the *Principia* from the author to Hanover in 1686, where he expected to find Mr Leibnitz; he was then abſent, but Fatio ſaw him often before his return to France in 1687, and does not ſay that the book was not given him. Read along with theſe diſſertations Dr Keill's letter to John Bernoulli and others, publiſhed in the *Journal Literaire de la Hayée* 1714, and to John Bernoulli in 1719.

9 Particularly of Leibnitz.

Newton has been accuſed of a ſimilar overſight by John Bernoulli, (who indeed calls it a miſtake in principle) in his Propoſition X. Book 2. on the very ſubject we are now conſidering. But Dr Keill has ſhown it to be only an overſight, in drawing the tangent on the wrong ſide of the ordinate. For in this very propoſition Newton exhibits, in the ſtricteſt and moſt beautiful manner, the difference between the geometrical and algebraical manner of conſidering the ſubject; and expreſsly warns the reader, that *his* algebraical ſymbol expreſſes the deflection only, and not the variation of the increment of the ordinate. It is therefore in the laſt degree improbable that he would make this miſtake. He moſt expreſsly does not; and as to the real miſtake, which he corrected in the ſecond edition, the writer of this article has in his poſſeſſion a manuſcript copy of notes and illuſtrations on the whole Principia, written in 1693 by Dr David Gregory, Savilian profeſſor of aſtronomy at Oxford, at the deſire of Mr Newton, as preparatory for a new edition, where he has rectified this and ſeveral other miſtakes in that work, and ſays that Mr Newton had ſeen and approved of the amendments. We mention theſe particulars, becauſe Mr Bernoulli publiſhed an elegant diſſertation on this ſubject in the Leipſic Acts in 1713; in which he charges Newton (though with many proteſtations of admiration and reſpect) with this miſtake in principle; and ſays, that he communicated his correction to Mr Newton by his nephew Nicholas Bernoulli, that it might be corrected in the new edition, which he heard was in the preſs. And he afterwards adds, that it appears by ſome ſheets being cancelled, and new ones ſubſtituted in this part of the work, that the miſtake would have continued, had he not corrected it. We would deſire our readers to conſult this diſſertation, which is extremely elegant, and will be of ſervice to us in this article; and let them compare the civil things which is here ſaid of the *vir incomparabilis*, the *omni laude major*, the *ſummus Newtonus*, with what the ſame author, in the ſame year, in the Leipſic Acts, but under a borrowed name, ſays of him. Our readers will have no heſitation in aſcribing this letter to this author. For, after praiſing John Bernoulli as *ſummus geometra, natus ad ſummorum geometrarum paralogiſmos corrigendos, ſummi candoris ut et modeſtiæ*, he betrays himſelf by an unguarded warmth, when defending J. B.'s demonſtration of the inverſe problem of centripetal forces, by calling it MEAM *demonſtrationem*.

10 Newton accuſed of a ſimilar miſtake by J. Bernoulli,

11 But falſely.

12 Inſincerity of Bernoulli with reſpect to Newton.

Let our readers now conſider the ſcope and intention of this diſſertation on projectiles, and judge whether the author's aim was to inſtruct the world, or to acquire fame, by correcting Newton. The diſſertation does not contain one theorem, one corollary, nor one ſtep of argument, which is not to be found in Newton's firſt edition; nor has he gone farther than Newton's ſingle propoſition the Xth. To us it appears an exact companion to his propoſition on centripetal forces, which he boaſts of having firſt demonſtrated, although it is in every ſtep a tranſcript of the 42d of the 1ſt Book of Newton's Principia, the geometrical language of Newton being changed into algebraic, as he has in the preſent caſe changed Newton's algebraic analyſis into a very elegant geometrical one.

We hope to be forgiven for this long digreſſion. It is a very curious piece of literary hiſtory, and ſhows the combination which envy and want of honourable principle had formed againſt the reputation of our illuſtrious

illuſtrious countryman; and we think it our duty to embrace any opportunity of doing it juſtice.—To return to our ſubject:

13 Accurate meaſure of the accelerative power of gravity.

The accurate meaſure of the accelerative power of gravity, is the *fall* $16\frac{1}{12}$ feet, if we meaſure it by the ſpace, or the *velocity* of $32\frac{1}{6}$ feet per ſecond, if we take the velocity. It will greatly facilitate calculation, and will be ſufficiently exact for all our purpoſes, if we take 16 and 32, ſuppoſing that a body falls 16 feet in a ſecond, and acquires the velocity of 32 feet per ſecond. Then, becauſe the heights are as the ſquares of the times, and as the ſquares of the acquired velocities, a body will fall one foot in one fourth of a ſecond, and will

14 General formulæ deduced.

acquire the velocity of eight feet per ſecond. Now let h expreſs the height in feet, and call it the PRODUCING HEIGHT; v the velocity in feet per ſecond, and call it the PRODUCED VELOCITY, the velocity DUE; and t the time in ſeconds.—We ſhall have the following formulæ, which are of eaſy recollection, and will ſerve, without tables, to anſwer all queſtions relative to projectiles.

$$\text{I. } v = 8\sqrt{h}, = 8 \times 4t, = 32t$$

$$\text{II. } t = \frac{\sqrt{h}}{4}, = \frac{v}{32}$$

$$\text{III. } \sqrt{h} = \frac{v}{8}, = 4t$$

$$\text{IV. } h = \frac{v^2}{64}, = 16t^2$$

15 Examples of their uſe in falling bodies,

To give ſome examples of their uſe, let it be required,

1. To find the time of falling through 256 feet. Here $h = 256$, $\sqrt{256} = 16$, and $\frac{16}{4} = 4$. Anſwer 4″.

2. To find the velocity acquired by falling four ſeconds. $t = 4 \cdot 32 \times 4 = 128$ feet per ſecond.

3. To find the velocity acquired by falling 625 feet. $h = 625 \cdot \sqrt{h} = 25 \cdot 8\sqrt{h} = 200$ feet per ſecond.

16 In bodies projected upwards,

4. To find the height to which a body will riſe when projected with the velocity of 56 feet per ſecond, or the height through which a body muſt fall to acquire this velocity.

$$v = 56 \cdot \frac{56}{8} = 7, = \sqrt{h} \cdot 7^2 = h, = 49 \text{ feet.}$$

$$\text{or } 56^2 = 3136 \cdot \frac{3136}{64} = 49 \text{ feet.}$$

17 And directly downwards.

5. Suppoſe a body projected directly downwards with the velocity of 10 feet per ſecond; what will be its velocity after four ſeconds? In four ſeconds it will have acquired, by the action of gravity, the velocity of 4×32, or 128 feet, and therefore its whole velocity will be 138 feet per ſecond.

6. To find how far it will have moved, compound its motion of projection, which will be 40 feet in four ſeconds, with the motion which gravity alone would have given it in that time, which is 256 feet; and the whole motion will be 296 feet.

7. Suppoſe the body projected as already mentioned, and that it is required to determine the time it will take to go 296 feet downwards, and the velocity it will have acquired.

Find the height x, through which it muſt fall to acquire the velocity of projection, 10 feet, and the time y of falling from this height. Then find the time z of falling through the height $296 + x$, and the velocity v acquired by this fall. The time of deſcribing the 296 feet will be $z - y$, and v is the velocity required.

From ſuch examples, it is eaſy to ſee the way of anſwering every queſtion of the kind.

18 More general formulæ.

Writers on the higher parts of mechanics always compute the actions of other accelerating and retarding forces by comparing them with the acceleration of gravity, and in order to render their expreſſions more general, uſe a ſymbol, ſuch as g for gravity, leaving the reader to convert it into numbers. Agreeably to this view, the general formulæ will ſtand thus:

$$\text{I. } v = \sqrt{2gh}, \text{ i.e. } \sqrt{2}\sqrt{g}\sqrt{h}, = gt,$$

$$\text{II. } t = \frac{v}{g}, = \frac{\sqrt{4h}}{\sqrt{2g}}, = \sqrt{\frac{4h}{2g}}, = \sqrt{\frac{2h}{g}}$$

$$\text{IIII. } h = \frac{v^2}{2g}, = \frac{gt^2}{2}$$

In all theſe equations, gravity, or its accelerating power, is eſtimated, as it ought to be, by the change of velocity which it generates in a particle of matter in an unit of time. But many mathematicians, in their inveſtigations of curvilineal and other varied motions, meaſure it by the deflection which it produces in this time from the tangent of the curve, or by the increment by which the ſpace deſcribed in an unit of time exceeds the ſpace deſcribed in the preceding unit. This is but one half of the increment which gravity would have produced, had the body moved through the whole moment with the acquired addition of velocity. In this ſenſe of the ſymbol g, the equations ſtand thus:

$$\text{I. } v = 2\sqrt{gh}, = 2gt$$

$$\text{II. } t = \sqrt{\frac{h}{g}}, = \frac{v}{2g}$$

$$\text{IV. } h = \frac{v^2}{4g}, = gt^2, \text{ and } \sqrt{h} = \frac{v}{2\sqrt{g}}$$

It is alſo very uſual to conſider the accelerating force of gravity as the unit of compariſon. This renders the expreſſions much more ſimple. In this way, v expreſſes not the velocity, but the height neceſſary for acquiring it, and the velocity itſelf is expreſſed by $\sqrt{v}$. To reduce ſuch an expreſſion of a velocity to numbers, we muſt multiply it by $\sqrt{2g}$, or by $2\sqrt{g}$, according as we make g to be the generated velocity, or the ſpace fallen through in the unit of time.

19 Bodies projected obliquely,

This will ſuffice for the perpendicular aſcents or deſcents of heavy bodies, and we proceed to conſider their motions when projected obliquely. The circumſtance which renders this an intereſting ſubject, is, that the flight of cannon ſhot and ſhells are inſtances of ſuch motion, and the art of gunnery muſt in a great meaſure depend on this doctrine.

Let a body B (fig. 2.), be projected in any direction BC, not perpendicular to the horizon, and with any velocity. Let AB be the height producing this velocity; that is, let the velocity be that which a heavy body would acquire by falling freely through AB. It is required to determine the path of the body, and all the circumſtances of its motion in this path?

Plate cccxvii.

1. It is evident, that by the continual action of gra-

vity, the body will be continually deflected from the line BC, and will describe a curve line BVG, concave towards the earth.

20 Describes a parabola.

2. This curve line is a parabola, of which the vertical line ABE is a diameter, B the vertex of this diameter, and BC a tangent in B.

Through any two points V, G of the curve draw VC, GH parallel to AB, meeting BC in C and H, and draw VE, GK parallel to BC, meeting AB in E, K. It follows, from the composition of motions, that the body would arrive at the points V, G of the curve in the same time that it would have uniformly described BC, BH, with the velocity of projection; or that it would have fallen through BE, BK, with a motion uniformly accelerated by gravity; therefore the times of describing BC, BH, uniformly, are the same with the times of falling through BE, BK. But, because the motion along BH is uniform, BC is to BH as the time of describing BC to the time of describing BH, which we may express thus, BC : BH = T, BC : T, BH, = T, BE : T, BK. But, because the motion along BK is uniformly accelerated, we have BE : BK = T^2, BE : T^2, BK, = BC^2 : BH^2, = EV^2 : KG^2; therefore the curve BVG is such, that the abscissæ BE, BK are as the squares of the corresponding ordinates EV, KG; that is, the curve BVG is a parabola, and BC, parallel to the ordinates, is a tangent in the point B.

3. If through the point A there be drawn the horizontal line AD *d*, it is the directrix of the parabola.

Let BE be taken equal to AB. The time of falling through BE is equal to the time of falling through AB; but BC is described with the velocity acquired by falling through AB: and therefore by n° 4. of perpendicular descents, BC is double of AB, and EV is double of BE; therefore $EV^2 = 4BE^2$, $= 4BE \times AB$, $= BE \times 4AB$, and 4AB is the parameter or *latus rectum* of the parabola BVG, and AB being one-fourth of the parameter, AD is the directrix.

4. The times of describing the different arches BV, VG of the parabola are as the portions BC, BH of the tangent, or as the portions AD, A *d* of the directrix, intercepted by the same vertical lines AB, CV, HG; for the times of describing BV, BVG are the same with those of describing the corresponding parts BC, BH of the tangent, and are proportional to these parts, because the motion along BH is uniform; and BC, BH are proportional to AD, A *d*.

Therefore the motion estimated horizontally is uniform.

5. The velocity in any point G of the curve is the same with that which a heavy body would acquire by falling from the directrix along *d* G. Draw the tangent GT, cutting the vertical AB in T; take the points *a*, *f*, equidistant from A and *d*, and extremely near them, and draw the verticals *a b*, *f g*; let the points *a*, *f*, continually approach A and *d*, and ultimately coincide with them. It is evident that B *b* will ultimately be to *g* G, in the ratio of the velocity at B to the velocity at G; for the portions of the tangent ultimately coincide with the portions of the curve, and are described in equal times; but B *b* is to *g* G as BH to TG: therefore the velocity at B is to that at G as BH to TG. But, by the properties of the parabola, BH^2 is to TG^2 as AB to *d* G; and AB is to *d* G as the square of the velocity acquired by falling through AB to the square of the velocity acquired by falling through *d* G; and the velocity in BH, or in the point B of the parabola, is the velocity acquired by falling along AB; therefore the velocity in TG, or in the point G of the parabola, is the velocity acquired by falling along *d* G.

21 The parabolic theory ingenious, but of little use in practice.

These few simple propositions contain all the theory of the motion of projectiles in vacuo, or independent on the resistance of the air; and being a very easy and neat piece of mathematical philosophy, and connected with very interesting practice, and a very respectable profession, they have been much commented on, and have furnished matter for many splendid volumes. But the air's resistance occasions such a prodigious diminution of motion in the great velocities of military projectiles, that this parabolic theory, as it is called, is hardly of any use. A musket-ball, discharged with the ordinary allotment of powder, issues from the piece with the velocity of 1670 feet per second: this velocity would be acquired by falling from the height of eight miles. If the piece be elevated to an angle of 45°, the parabola should be of such extent that it would reach 16 miles on the horizontal plain; whereas it does not reach much above half a mile. Similar deficiencies are observed in the ranges of cannon shot.

22 A short view of it.

We do not propose, therefore, to dwell much on this theory, and shall only give such a synoptical view of it as shall make our readers understand the more general circumstances of the theory, and be masters of the language of the art.

Plate CCCCXVII.

Let OB (fig. 3.) be a vertical line. About the centres A and B, with the distance AB, describe the semicircles ODB, AHK, and with the axis AB, and semiaxis GE, equal to AB, describe the semi-ellipse AEB: with the focus B, vertex A, diameter AB, and tangent AD, parallel to the horizon, describe the parabola APS.

Let a body be projected from B, in any direction BC, with the velocity acquired by falling through AB. By what has already been demonstrated, it will describe a parabola BVPM. Then,

1. ADL parallel to the horizon is the directrix of every parabola which can be described by a body projected from B with this velocity. This is evident.

2. The semicircle AHK is the locus of all the foci of these parabolas: For the distance BH of a point B of any parabola from the directrix AD is equal to its distance BF from the focus F of that parabola; therefore the foci of all the parabolas which pass through B, and have AD for their directrix, must be in the circumference of the circle which has AB for its radius, and B for its centre.

3. If the line of direction BC cut the upper semicircle in C, and the vertical line CF be drawn, cutting the lower semicircle in F, F is the focus of the parabola BVPM, described by the body which is projected in the direction BC, with the velocity acquired by falling through BA: for drawing AC, BF, it is evident that ACFB is a rhombus, and that the angle ABF is bisected by BC, and therefore the focus lies in the line BF; but it also lies in the circumference AFK, and therefore in F.

If C is in the upper quadrant of ODB, F is in the upper

upper quadrant of AFK; and if C be in the lower quadrant of ODB (as when BC is the line of direction) then the focus of the correſponding parabola B *v* M is in the lower quadrant of AHK, as at *f*.

4. The ellipſis AEB is the locus of the vertex of all the parabolas, and the vertex V of any one of them BVPM is in the interſection of this ellipſis with the vertical CF: for let this vertical cut the horizontal lines AD, GE, BN, in θ, λ, N. Then it is plain that N λ is half of N θ, and λ V is half of C θ; therefore NV is half of NC, and V is the vertex of the axis.

If the focus is in the upper or lower quadrant of the circle AHK, the vertex is in the upper or the lower quadrant of the ellipſe AEG.

5. If BFP be drawn through the focus of any one of the parabolas, ſuch as BVM, cutting the parabola APS in P, the parabola BVM touches the parabola APS in P: for drawing P ſ × parallel to AB, cutting the directrix O × of the parabola APS in ×, and the directrix AL of the parabola BVM in ſ, then PB = P×; but BF = BA, = AO, = × ſ: therefore P ſ = PF, and the point P is in the parabola BVM. Alſo the tangents to both parabolas in P coincide, for they biſect the angle × PB; therefore the two parabolas having a common tangent, touch each other in P.

Cor. All the parabolas which can be deſcribed by a body projected from B, with the velocity acquired by falling through AB, will touch the concavity of the parabola APS, and lie wholly within it.

6. P is the moſt diſtant point of the line BP which can be hit by a body projected from B with the velocity acquired by falling through AB. For if the direction is more elevated than BC, the focus of the parabola deſcribed by the body will lie between F and A, and the parabola will touch APS in ſome point between P and A; and being wholly within the parabola APS, it muſt cut the line BP in ſome point within P. The ſame thing may be ſhown when the direction is leſs elevated than BC.

7. The parabola APS is the locus of the greateſt ranges on any planes BP, BS, &c. and no point lying without this parabola can be ſtruck.

8. The greateſt range on any plane BP is produced when the line of direction BC biſects the angle OBP formed by that plane with the vertical: for the parabola deſcribed by the body in this caſe touches APS in P, and its focus is in the line BP, and therefore the tangent BC biſects the angle OBP.

Cor. The greateſt range on a horizontal plane is made with an elevation of 45°.

9. A point M in any plane BS, lying between B and S, may be ſtruck with two directions, BC and B *c*; and theſe directions are equidiſtant from the direction B *t*, which gives the greateſt range on that plane: for if about the centre M, with the diſtance ML from the directrix AL, we deſcribe a circle LF *f*, it will cut the circle AHK in two points F and *f*, which are evidently the foci of two parabolas BVM, B *v* M, having the directrix AL and diameter ABK. The interſection of the circle ODB, with the verticals FC, *f c*, determine the directions BC, B *c* of the tangents. Draw A *t* parallel to BS, and join *t* B, C *c*, F *f*; then OB *t* = ½ OBS, and B *t* is the direction which gives the greateſt range on the plane BS: but becauſe F *f* is a chord of the circles deſcribed round the centres B and M, F *f* is perpendicular to BM, and C *c* to A *t*, and the arches C *t*, *c t* are equal; and therefore the angles CB *t*, *c* B *t* are equal.

Thus we have given a general view of the ſubject, which ſhows the connection and dependence of every circumſtance which can influence the reſult; for it is evident that to every velocity of projection there belongs a ſet of parabolas, with their directions and ranges; and every change of velocity has a line AB correſponding to it, to which all the others are proportional. As the height neceſſary for acquiring any velocity increaſes or diminiſhes in the duplicate proportion of that velocity, it is evident that all the ranges with given elevations will vary in the ſame proportion, a double velocity giving a quadruple range, a triple velocity giving a noncuple range, &c. And, on the other hand, when the ranges are determined beforehand (which is the uſual caſe), the velocities are in the ſubduplicate proportion of the ranges. A quadruple range will require a double velocity, &c.

23 Experience principally directs the practical gunner.

On the principles now eſtabliſhed is founded the ordinary theory of gunnery, furniſhing rules which are to direct the art of throwing ſhot and ſhells, ſo as to hit the mark with a determined velocity.

But we muſt obſerve, that this theory is of little ſervice for directing us in the practice of cannonading. Here it is neceſſary to come as near as we can to the object aimed at, and the hurry of ſervice allows no time for geometrical methods of pointing the piece after each diſcharge. The gunner either points the cannon directly to the object, when within 200 or 300 yards of it, in which caſe he is ſaid to ſhoot point blank (*pointer au blanc*, i. e. at the white mark in the middle of the gunners target); or, if at a greater diſtance, he eſtimates to the beſt of his judgment the deflection correſponding to his diſtance, and points the cannon accordingly. In this he is aided by the greater thickneſs at the breech of a piece of ordnance. Or, laſtly, when the intention is not to batter, but to rake along a line occupied by the enemy, the cannon is elevated at a conſiderable angle, and the ſhot diſcharged with a ſmall force, ſo that it drops into the enemy's poſt, and bounds along the line. In all theſe ſervices the gunner is directed entirely by trial, and we cannot ſay that this parabolic theory can do him any ſervice.

The principal uſe of it is to direct the bombardier in throwing ſhells. With theſe it is propoſed to break down or ſet fire to buildings, to break through the vaulted roofs of magazines, or to intimidate and kill troops by burſting among them. Theſe objects are always under cover of the enemy's works, and cannot be touched by a direct ſhot. The bombs and carcaſſes are therefore thrown upwards, ſo as to get over the defences and produce their effect.

Theſe ſhells are of very great weight, frequently exceeding 200 lbs. The mortars from which they are diſcharged muſt therefore be very ſtrong, that they may reſiſt the exploſion of gunpowder which is neceſſary for throwing ſuch a maſs of matter to a diſtance; they are conſequently unwieldy, and it is found moſt convenient to make them almoſt a ſolid and immoveable lump. Very little change can be made in their elevation, and therefore their ranges are regulated by the velocities given to the ſhell. Theſe again are produced by the quantities

of powder in the charge; and experience (confirming the beſt theoretical notions that we can form of the ſubject) has taught us, that the ranges are nearly proportional to the quantities of powder employed, only not increaſing quite ſo faſt. This method is much eaſier than by differences of elevation; for we can ſelect the elevation which gives the greateſt range on the given plane, and then we are certain that we are employing the ſmalleſt quantity of powder with which the ſervice can be performed: and we have another advantage, that the deviations which unavoidable cauſes produce in the real directions of the bomb will then produce the ſmalleſt poſſible deviation from the intended range. This is the caſe in moſt mathematical maxima.

24 The moving force in theory different from that in practice.

In military projectiles the velocity is produced by the exploſion of a quantity of gunpowder; but in our theory it is conceived as produced by a fall from a certain height, by the proportions of which we can accurately determine its quantity. Thus a velocity of 1600 feet per ſecond is produced by a fall from the height of 40,000 feet or 1333 yards.

Plate CCCCXVII.

The height CA (fig. 4.) for producing the velocity of projection is called, in the language of gunnery, the IMPETUS. We ſhall expreſs it by the ſymbol h.

The diſtance AB to which the ſhell goes on any plane AB is called the AMPLITUDE or the RANGE r.

The angle DBA, made by the vertical line and the plane AB, may be called the angle of POSITION of that plane, p.

The angle DAB, made by the axis or direction of the piece, and the direction of the object, may be called the angle of ELEVATION of the piece above the plane AB, e.

The angle ZAD, made by the vertical line, and the direction of the piece, may be called the ZENITH diſtance, z.

The relations between all the circumſtances of velocity, diſtance, poſition, elevation, and time, may be included in the following propoſitions.

25 Relations between the velocity, diſtance, &c.

I. Let a ſhell be projected from A, with the velocity acquired by falling through CA, with the intention of hitting the mark B ſituated in the given line AB.

Make ZA = 4AC, and draw BD perpendicular to the horizon. Deſcribe on ZA an arch of a circle ZDA, containing an angle equal to DBA, and draw AD to the interſection of this circle with DB; then will a body projected from A, in the direction AD, with the velocity acquired by falling through CA, hit the mark B.

For, produce CA downwards, and draw BF parallel to AD, and draw ZD. It is evident from the conſtruction that AB touches the circle in B, and that the angles ADZ, DBA, are equal, as alſo the angles AZD, DAB; therefore the triangles ZAD, ADB are ſimilar.

$$\text{Therefore } BD : DA = DA : AZ,$$
$$\text{And } DA^2 = BD \times AZ;$$
$$\text{Therefore } BF^2 = AF \times AZ, = AF \times 4AC.$$

Therefore a parabola, of which AF is a diameter, and AZ its parameter, will paſs through B, and this parabola will be the path of the ſhell projected as already mentioned.

Remark. When BD cuts this circle, it cuts it in two points D, d; and there are two directions which will ſolve the problem. If B′D′ only touches the circle in D′, there is but one direction, and AB′ is the greateſt poſſible range with this velocity. If the vertical line through B does not meet the circle, the problem is impoſſible, the velocity being too ſmall. When B′D′ touches the circle, the two directions AD′ and Ad′ coaleſce into one direction, producing the greateſt range, and biſecting the angle ZAB; and the other two directions AD, Ad, producing the ſame range AB, are equidiſtant from AD′, agreeably to the general propoſition.

It is evident that $AZ : AD = S,ADZ : S,AZD, = S,DBA : S,DAB, = S,p : S,e$
And $AD : DB = S,DBA : S,DAB, = S,p : S,e$
And $DB : AB = S,DAB : S,ADB, = S,e : S,z$
Therefore $AZ : AB = S^2,p \times S,e : S^2,e \times S,z ; = S^2,p : S,e \times S,z$
Or $4h : r = S^2,p : S,e \times S,z$, and $4h \times S,e \times S,z = r \times S^2,p$

Hence we obtain the relations wanted.

$$\text{Thus } h = \frac{r \times S^2,p}{4S,e \times S,z}, \text{ and } r = \frac{4h \times S,e \times S,z}{S^2,p}$$

$$\text{And } S,z = \frac{r \times S^2,p}{4h \times S,e}, \text{ and } S,e = \frac{r \times S^2,p,}{4h \times S,z}.$$

26 To calculate the time of flight.

The only other circumſtance in which we are intereſted is the time of the flight. A knowledge of this is neceſſary for the bombardier, that he may cut the fuzes of his ſhells to ſuch lengths as that they may burſt at the very inſtant of their hitting the mark.

Now $AB : DB = \text{Sin, } ADB : \text{Sin, } DAB, = S,z : S,e$, and $DB = \frac{r \times S,e}{S,z}$. But the time of the flight is the ſame with the time of falling through DB, and 16 feet : $DB = 1'' : t''^2$. Hence $t''^2 = \frac{r \times S,e}{16S,z}$, and we have the following eaſy rule.

From the ſum of the logarithms of the range, and of the ſine of elevation, ſubtract the ſum of the logarithms of 16, and of the ſine of the zenith diſtance, half the remainder is the logarithm of the time in ſeconds.

This becomes ſtill eaſier in practice; for the mortar ſhould be ſo elevated that the range is a maximum: in which caſe AB = DB, and then half the difference of the logarithms of AB and of 16 is the logarithm of the time in ſeconds.

27 The theory of gunnery compared with experiment.

Such are the deductions from the general propoſitions which conſtitute the ordinary theory of gunnery. It remains to compare them with experiment.

In ſuch experiments as can be performed with great accuracy in a chamber, the coincidence is as great as can be wiſhed. A jet of water, or mercury, gives us the fineſt example, becauſe we have the whole parabola exhibited to us in the ſimultaneous places of the ſucceeding particles. Yet even in theſe experiments a deviation can be obſerved. When the jet is made on a horizontal plane, and the curve carefully traced on a perpendicular plane held cloſe by it, it is found that the diſtance between the higheſt point of the curve and the mark is leſs than the diſtance between it and the ſpout, and that the deſcending branch of the curve is more perpendicular than the aſcending branch. And this difference is more remarkable as the jet is made with

greater velocity, and reaches to a greater diſtance. This is evidently produced by the reſiſtance of the air, which diminiſhes the velocity, without affecting the gravity of the projectile. It is ſtill more ſenſible in the motion of bombs. Theſe can be traced through the air by the light of their fuzes; and we ſee that their higheſt point is always much nearer to the mark than to the mortar on a horizontal plane.

The greateſt horizontal range on this plane ſhould be when the elevation is 45°. It is always found to be much lower.

The ranges on this plane ſhould be as the ſines of twice the elevation.

A ball diſcharged at the elev. 19°. 5′ ranged 448 yards
at 9. 45 330
It ſhould have ranged by theory 241

The range at an elevation of 45° ſhould be twice the impetus. Mr Robins found that a muſket-ball, diſcharged with the uſual allotment of powder, had the velocity of 1700 feet in a ſecond. This requires a fall of 45156 feet, and the range ſhould be 90312, or $17\frac{1}{8}$ miles; whereas it does not much exceed half a mile. A 24 pound ball diſcharged with 16 pounds of powder ſhould range about 16 miles; whereas it is generally ſhort of 3 miles.

28 This comparison ſhews the deficiency of the theory.

Such facts ſhow incontrovertibly how deficient the parabolic theory is, and how unfit for directing the practice of the artilleriſt. A very ſimple conſideration is ſufficient for rendering this obvious to the moſt uninſtructed. The reſiſtance of the air to a very light body may greatly exceed its weight. Any one will feel this in trying to move a fan very rapidly through the air; therefore this reſiſtance would occaſion a greater deviation from uniform motion than gravity would *in that body*. Its path, therefore, through the air may differ more from a parabola than the parabola itſelf deviates from the ſtraight line.

It is for ſuch cogent reaſons that we preſume to ſay, that the voluminous treatiſes which have been publiſhed on this ſubject are nothing but ingenious amuſements for young mathematicians. Few perſons who have been much engaged in the ſtudy of mechanical philoſophy have miſſed this opportunity in the beginning of their ſtudies. The ſubject is eaſy. Some property of the parabola occurs, by which they can give a neat and ſyſtematic ſolution of all the queſtions; and at this time of ſtudy it ſeems a conſiderable eſſay of ſkill. They are tempted to write a book on the ſubject; and it finds readers among other young mechanicians, and employs all the mathematical knowledge that moſt of the young gentlemen of the military profeſſion are poſſeſſed of. But theſe performances deſerve little attention from the practical artilleriſt. All that ſeems poſſible to do for his education is, to multiply judicious experiments on real pieces of ordnance, with the charges that are uſed in actual ſervice, and to furniſh him with tables calculated from ſuch experiments.

Theſe obſervations will ſerve to juſtify us for having given ſo conciſe an account of this doctrine of the parabolic flight of bodies.

29 Cauſes of this deficiency.

But it is the buſineſs of a philoſopher to inquire into the cauſes of ſuch a prodigious deviation from a well founded theory, and having diſcovered them, to aſcertain preciſely the deviations they occaſion. Thus we ſhall obtain another theory, either in the form of the parabolic theory corrected, or as a ſubject of independent diſcuſſion. This we ſhall now attempt.

30 Effect of the atmoſphere.

The motion of projectiles is performed in the atmoſphere. The air is diſplaced, or put in motion. Whatever motion it acquires muſt be taken from the bullet. The motion communicated to the air muſt be in the proportion of the quantity of air put in motion, and of the velocity communicated to it. If, therefore, the diſplaced air be always *ſimilarly diſplaced*, whatever be the velocity of the bullet, the motion communicated to it, and loſt by the bullet, muſt be proportional to the ſquare of the velocity of the bullet and to the denſity of the air jointly. Therefore the diminution of its motion muſt be greater when the motion itſelf is greater, and in the very great velocity of ſhot and ſhells it muſt be prodigious. It appears from Mr Robins's experiments that a globe of $4\frac{1}{2}$ inches in diameter, moving with the velocity of 25 feet in a ſecond, ſuſtained a reſiſtance of 315 grains, nearly $\frac{1}{4}$ of an ounce. Suppoſe this ball to move 800 feet in a ſecond, that is 32 times faſter, its reſiſtance would be 32×32 times $\frac{1}{4}$ of an ounce, or 768 ounces or 48 pounds. This is four times the weight of a ball of caſt iron of this diameter; and if the initial velocity had been 1600 feet per ſecond, the reſiſtance would be at leaſt 16 times the weight of the ball. It is indeed much greater than this.

31 Compared with that of gravity.

This reſiſtance, operating conſtantly and uniformly on the ball, muſt take away four times as much from its velocity as its gravity would do in the ſame time. We know that in one ſecond gravity would reduce the velocity 800 to 768 if the ball were projected ſtraight upwards. This reſiſtance of the air would therefore reduce it in one ſecond to 672, if it operated uniformly; but as the velocity diminiſhes continually by the reſiſtance, and the reſiſtance diminiſhes along with the velocity, the real diminution will be ſomewhat leſs than 128 feet. We ſhall, however, ſee afterwards that in one ſecond its velocity will be reduced from 800 to 687. From this ſimple inſtance we ſee that the reſiſtance of the air muſt occaſion great deviation from parabolic motion.

32 And conſidered as a retarding force.

In order to judge accurately of its effect, we muſt conſider it as a retarding force, in the ſame way as we conſider gravity. The weight W of a body is the aggregate of the action of the force of gravity g on each particle of the body. Suppoſe the number of equal particles, or the quantity of matter, of a body to be M, then W is equivalent to gM. In like manner, the reſiſtance R, which we obſerve in any experiment, is the aggregate of the action of a retarding force R′ on each particle, and is equivalent to R′M: and as g is equal to $\frac{W}{M}$, ſo R′ is equal to $\frac{R}{M}$. We ſhall keep this diſtinction in view, by adding the differential mark ′ to the letter R or r, which expreſſes the aggregate reſiſtance.

33 The reſiſtance of the air not uniform.

If we, in this manner, conſider reſiſtance as a retarding force, we can compare it with any other ſuch force by means of the retardation which it produces in ſimilar circumſtances. We would compare it with gravity by comparing the diminution of velocity which its uniform action produces in a given time with the diminution produced in the ſame time by gravity. But we have no opportunity of doing this directly; for when the reſiſtance of the air diminiſhes the velocity of a body, it diminiſhes it gradually, which occaſions a gradual diminution of its own

own intenſity. This is not the caſe with gravity, which has the ſame action on a body in motion or at reſt. We cannot, therefore, obſerve the uniform action of the air's reſiſtance as a retarding force. We muſt fall on ſome other way of making the compariſon. We can ſtate them both as dead preſſures. A ball may be fitted to the rod of a ſpring ſtillyard, and expoſed to the impulſe of the wind. This will compreſs the ſtillyard to the mark 3, for inſtance. Perhaps the weight of the ball will compreſs it to the mark 6. We know that half this weight would compreſs it to 3. We account this equal to the preſſure of the air, becauſe they balance the ſame elaſticity of the ſpring. And in this way we can eſtimate the reſiſtance by weights, whoſe preſſures are equal to its preſſure, and we can thus compare it with other reſiſtances, weights, or any other preſſures. In fact, we are meaſuring them all by the elaſticity of the ſpring. This elaſticity in its different poſitions is ſuppoſed to have the proportions of the weights which keep it in theſe poſitions. Thus we reaſon from the nature of gravity, no longer conſidered as a dead preſſure, but as a retarding force; and we apply our concluſions to reſiſtances which exhibit the ſame preſſures, but which we cannot make to act uniformly. This ſenſe of the words muſt be carefully remembered whenever we ſpeak of reſiſtances in pounds and ounces.

34 Gravity and reſiſtance compared when they are equal.

The moſt direct and convenient way of ſtating the compariſon between the reſiſtance of the air and the accelerating force of gravity, is to take a caſe in which we know that they are equal. Since the reſiſtance is here aſſumed as proportional to the ſquare of the velocity, it is evident that the velocity may be ſo increaſed that the reſiſtance ſhall equal or exceed the weight of the body. If a body be already moving downwards with this velocity, it cannot accelerate; becauſe the accelerating force of gravity is balanced by an equal retarding force of reſiſtance. It follows from this remark, that this velocity is the greateſt that a body can acquire by the force of gravity only. Nay, we ſhall afterwards ſee that it never can completely attain it; becauſe as it approaches to this velocity, the remaining accelerating force decreaſes faſter than the velocity increaſes. It may therefore be called the limiting or TERMINAL velocity by gravity.

Let a be the height through which a heavy body muſt fall, in vacuo, to acquire its terminal velocity in air. If projected directly upwards with this velocity, it will riſe again to this height, and the height is half the ſpace which it would deſcribe uniformly, with this velocity, in the time of its aſcent. Therefore the reſiſtance to this velocity being equal to the weight of the body, it would extinguiſh this velocity, by its *uniform* action, in the ſame time, and after the ſame diſtance, that gravity would.

Now let g be the velocity which gravity generates or extinguiſhes during an unit of time, and let u be the terminal velocity of any particular body. The theorems for perpendicular aſcents give us $g = \frac{u^2}{2a}$, u and a being both numbers repreſenting units of ſpace; therefore, in the preſent caſe, we have $r' = \frac{u^2}{2a}$. For the whole reſiſtance r, or $r'M$, is ſuppoſed equal to the weight, or to gM; and therefore r' is equal to g, $= \frac{u^2}{2a}$ and $2a = \frac{u^2}{g}$. There is a conſideration which ought to have place here. A body deſcends in air, not by the whole of its weight, but by the exceſs of its weight above that of the air which it diſplaces. It deſcends by its *ſpecific* gravity only as a ſtone does in water. Suppoſe a body 32 times heavier than air, it will be buoyed up by a force equal to $\frac{1}{32}$ of its weight; and inſtead of acquiring the velocity of 32 feet in a ſecond, it will only acquire a velocity of 31, even though it ſuſtained no reſiſtance from the *inertia* of the air. Let p be the weight of the body and π that of an equal bulk of air: the accelerative force of relative gravity on each particle will be $g \times 1 - \frac{\pi}{p}$; and this relative accelerating force might be diſtinguiſhed by another ſymbol γ. But in all caſes in which we have any intereſt, and particularly in military projectiles, $\frac{\pi}{p}$ is ſo ſmall a quantity that it would be pedantic affectation to attend to it. It is much more than compenſated when we make $g = 32$ feet inſtead of $32\frac{1}{12}$ which it ſhould be.

Let e be the time of this aſcent in oppoſition to gravity. The ſame theorems give us $eu = 2a$; and ſince the reſiſtance competent to this terminal velocity is equal to gravity, e will alſo be the time in which it would be extinguiſhed by the uniform action of the reſiſtance; for which reaſon we may call it the extinguiſhing time for this velocity. Let R and E mark the reſiſtance and extinguiſhing time for the ſame body moving with the velocity 1.

Since the reſiſtances are as the ſquares of the velocities, and the reſiſtance to the velocity u is $\frac{u^2}{2a}$, R will be $= \frac{1}{2a}$. Moreover, the times in which the ſame velocity will be extinguiſhed by different forces, acting uniformly, are inverſely as the forces, and gravity would extinguiſh the velocity 1 in the time $\frac{1}{g}$, $=$ (in theſe meaſures) to $\frac{1}{\frac{u^2}{2a}}$, $= \frac{2a}{u^2}$. Therefore we have the following proportion $\frac{1}{2a}(=R) : \frac{u^2}{2a}(=g) = \frac{2a}{u^2} : 2a$, and $2a$ is equal to E, the time in which the velocity 1 will be extinguiſhed by the uniform action of the reſiſtance competent to this velocity.

The velocity 1 would in this caſe be extinguiſhed after a motion uniformly retarded, in which the ſpace deſcribed is one-half of what would be uniformly deſcribed during the ſame time with the conſtant velocity 1. Therefore the ſpace thus deſcribed by a motion which begins with the velocity 1, and is uniformly retarded by the reſiſtance competent to this velocity, is equal to the height through which *this* body muſt fall *in vacuo* in order to acquire *its* terminal velocity in air.

All theſe circumſtances may be conceived in a manner which, to ſome readers, will be more familiar and palpable. The terminal velocity is that where the reſiſtance of the air balances and is equal to the weight of the body. The reſiſtance of the air to any particular body is as the ſquare of the velocity; therefore let R be the whole reſiſtance to the body moving with the velocity

1, and r the reſiſtance to its motion with the terminal velocity u; we muſt have $r = R \times u^2$, and this muſt be $= W$ the weight. Therefore, to obtain the terminal velocity, divide the weight by the reſiſtance to the velocity 1, and the quotient is the ſquare of the terminal velocity, or $\frac{W}{R} = u^2$: And this is a very expeditious method of determining it, if R be previouſly known.

Then the common theorems give a, the fall neceſſary for producing this velocity *in vacuo* $= \frac{u^2}{2g}$, and the time of the fall $= \frac{u}{g} = e$, and $eu = 2a$, = the ſpace uniformly deſcribed with the velocity u during the time of the fall, or its equal, the time of the extinction by the uniform action of the reſiſtance r; and, ſince r extinguiſhes it in the time e, R, which is u^2 times ſmaller, will extinguiſh it in the time $u^2 e$, and R will extinguiſh the velocity 1, which is u times leſs than u, in the time ue, that is, in the time $2a$; and the body, moving uniformly during the time $2a$, $= E$, with the velocity 1, will deſcribe the ſpace $2a$; and, if the body begin to move with the velocity 1, and be uniformly oppoſed by the reſiſtance R, it will be brought to reſt when it has deſcribed the ſpace a; and the ſpace in which the reſiſtance to the velocity 1 will extinguiſh that velocity by its uniform action, is equal to the height through which that body muſt fall *in vacuo* in order to acquire its terminal velocity in air. And thus every thing is regulated by the time E in which the velocity 1 is extinguiſhed by the uniform action of the correſponding reſiſtance, or by $2a$, which is the ſpace uniformly deſcribed during this time, with the velocity 1. And E and $2a$ muſt be expreſſed by the ſame number. It is a number of units, of time, or of length.

35 The compariſon made general.

Having aſcertained theſe leading circumſtances for an unit of velocity, weight, and bulk, we proceed to deduce the ſimilar circumſtances for any other magnitude; and, to avoid unneceſſary complications, we ſhall always ſuppoſe the bodies to be ſpheres, differing only in diameter and denſity.

Firſt, then, let the velocity be increaſed in the ratio of 1 to v.

The reſiſtance will now be $\frac{v^2}{2a}, = r$.

The extinguiſhing time will be $\frac{E}{v}, = e, = \frac{2a}{v}$, and $ev = 2a$; ſo that the rule is general, that the ſpace along which *any* velocity will be extinguiſhed by the uniform action of the correſponding reſiſtance, is equal to the height neceſſary for communicating the terminal velocity to *that* body by gravity. For ev is twice the ſpace through which the body moves while the velocity v is extinguiſhed by the uniform reſiſtance.

In the 2d place, let the diameter increaſe in the proportion of 1 to d. The aggregate of the reſiſtance changes in the proportion of the ſurface ſimilarly reſiſted, that is, in the proportion of 1 to d^2. But the quantity of matter, or number of particles among which this reſiſtance is to be diſtributed, changes in the proportion of 1 to d^3. Therefore the retarding power of the reſiſtance changes in the proportion of 1 to $\frac{1}{d}$. When the diameter was 1, the reſiſtance to a velocity 1 was $\frac{1}{2a}$. It muſt now be $\frac{1}{2ad}$. The time in which this diminiſhed reſiſtance will extinguiſh the velocity 1 muſt increaſe in the proportion of the diminution of force, and muſt now be Ed, or $2ad$, and the ſpace uniformly deſcribed during this time with the initial velocity 1 muſt be $2ad$; and this muſt ſtill be twice the height neceſſary for communicating the terminal velocity w to *this* body. We muſt ſtill have $g = \frac{w^2}{2ad}$; and therefore $w^2 = 2gad$, and $w = \sqrt{2gad}, = \sqrt{2ga}\sqrt{d}$. But $u = \sqrt{2ga}$. Therefore the terminal velocity w for this body is $= u\sqrt{d}$; and the height neceſſary for communicating it is ad. Therefore the terminal velocity varies in the ſubduplicate ratio of the diameter of the ball, and the fall neceſſary for producing it varies in the ſimple ratio of the diameter. The extinguiſhing time for the velocity v muſt now be $\frac{Ed}{v}$.

If, in the 3d place, the denſity of the ball be increaſed in the proportion of 1 to m, the number of particles among which the reſiſtance is to be diſtributed is increaſed in the ſame proportion, and therefore the retarding force of the reſiſtance is equally diminiſhed; and if the denſity of the air is increaſed in the proportion of 1 to n, the retarding force of the reſiſtance increaſes in the ſame proportion: hence we eaſily deduce theſe *general* expreſſions.

The terminal velocity $= u\sqrt{d}\frac{m}{n} - = \sqrt{2gad\frac{m}{n}}$.

The producing fall *in vacuo* $= ad\frac{m}{n}$

The retarding power of reſiſtance to any velocity $= r', = \frac{v^2}{2ad\frac{m}{n}}$.

The extinguiſhing time for any velocity $v = \frac{Edm}{vn}$.

And thus we ſee that the chief circumſtances are regulated by the terminal velocity, or are conveniently referred to it.

36 Units neceſſary by which the quantities may be meaſured.

To render the deductions from theſe premiſes perſpicuous, and for communicating diſtinct notions or ideas, it will be proper to aſſume ſome convenient units, by which all theſe quantities may be meaſured; and, as this ſubject is chiefly intereſting in the caſe of military projectiles, we ſhall adapt our units to this purpoſe. Therefore, let a ſecond be the unit of time, a foot the unit of ſpace and velocity, an inch the unit of diameter of a ball or ſhell, and a pound avoirdupoiſe the unit of preſſure, whether of weight or of reſiſtance; therefore g is 32 feet.

The great difficulty is to procure an abſolute meaſure of r, or u, or a; any one of theſe will determine the others.

37 Sir Iſaac Newton's endeavours in this way.

Sir Iſaac Newton has attempted to determine r by theory, and employs a great part of the ſecond book of the *Principia* in demonſtrating, that the reſiſtance to a ſphere moving with any velocity is to the force which would generate or deſtroy its whole motion in the time that it would uniformly move over $\frac{8}{3}$ of its diameter with this velocity as the denſity of the air is to the denſity of the ſphere. This is equivalent to demonſtrating that the reſiſtance of the air to a ſphere moving through it with any velocity, is equal to half the weight of a column

column of air having a great circle of the sphere for its base, and for its altitude the height from which a body must fall *in vacuo* to acquire this velocity. This appears from Newton's demonstration; for, let the specific gravity of the air be to that of the ball as 1 to m; then, because the times in which the same velocity will be extinguished by the uniform action of different forces are inversely as the forces, the resistance to this velocity would extinguish it in the time of describing $\frac{8}{3} m d$, d being the diameter of the ball. Now 1 is to m as the weight of the displaced air to the weight of the ball, or as $\frac{1}{3}$ of the diameter of the ball to the length of a column of air of equal weight. Call this length a; a is therefore equal to $\frac{1}{3} m d$. Suppose the ball to fall from the height a in the time t, and acquire the velocity u. If it moved uniformly with this velocity during this time, it would describe a space $= 2a$, or $\frac{4}{3} m d$. Now its weight would extinguish this velocity, or destroy this motion, in the same time, that is, in the time of describing $\frac{4}{3} m d$; but the resistance of the air would do this in the time of describing $\frac{8}{3} m d$; that is, in twice the time. The resistance therefore is equal to half the weight of the ball, or to half the weight of the column of air whose height is the height producing the velocity. But the resistances to different velocities are as the squares of the velocities; and therefore, as their producing heights, and, in general, the resistance of the air to a sphere moving with any velocity, is equal to the half weight of a column of air of equal section, and whose altitude is the height producing the velocity.

38 His result just, but his reasoning erroneous.

The result of this investigation has been acquiesced in by all Sir Isaac Newton's commentators. Many faults have indeed been found with his reasoning, and even with his principles; and it must be acknowledged that although this investigation is by far the most ingenious of any in the *Principia*, and sets his acuteness and address in the most conspicuous light, his reasoning is liable to serious objections, which his most ingenious commentators have not completely removed. However, the conclusion has been acquiesced in, as we have already stated, but as if derived from other principles, or by more logical reasoning. We cannot, however, say that the reasonings or assumptions of these mathematicians are much better than Newton's: and we must add, that all the causes of deviation from the duplicate ratio of the velocities, and the causes of increased resistance, which the later authors have valued themselves for discovering and introducing into their investigations, were pointed out by Sir Isaac Newton, but purposely omitted by him, in order to facilitate the discussion *in re difficillima*. (See *Schol.* prop. 37. b. ii.)

It is known that the weight of a cubic foot of water is $62\frac{1}{2}$ pounds, and that the medium density of the air is $\frac{1}{840}$ of water; therefore let a be the height producing the velocity (in feet), and d the diameter of the ball (in inches), and π the periphery of a circle whose diameter is 1; the resistance of the air will be $= \frac{62\frac{1}{2}}{840} \times \frac{\pi}{4} \times \frac{1}{144} \times \frac{a}{2} \times d^2 = \frac{a d^2}{4928\frac{1}{2}}$ pounds, very nearly, $= \frac{v^2}{4928\frac{1}{2} \times 64} d^2, = \frac{v^2 d^2}{315417}$ pounds.

We may take an example. A ball of cast iron weighing 12 pounds, is $4\frac{1}{2}$ inches in diameter. Suppose this ball to move at the rate of $25\frac{1}{10}$ feet in a second (the reason of this choice will appear afterwards). The height which will produce this velocity in a falling body is $9\frac{7}{8}$ feet. The area of its great circle is 0,11044 feet, or $\frac{11044}{1000000}$ of one foot. Suppose water to be 840 times heavier than air, the weight of the air incumbent on this great circle, and $9\frac{7}{8}$ feet high, is 0,081151 pounds: half of this is 0,0405755 or $\frac{405755}{10000000}$, or nearly $\frac{1}{11}$ of a pound. This should be the resistance of the air to this motion of the ball.

39 Necessity of experiment.

In all matters of physical discussion, it is prudent to confront every theoretical conclusion with experiment. This is particularly necessary in the present instance, because the theory on which this proposition is founded is extremely uncertain. Newton speaks of it with the most cautious diffidence, and secures the justness of the conclusions by the conditions which he assumes in his investigation. He describes with the greatest precision the state of the fluid in which the body must move, so as that the demonstrations may be strict, and leaves it to others to pronounce whether this is the real constitution of our atmosphere. It must be granted that it is not; and that many other suppositions have been introduced by his commentators and followers, in order to suit his investigation (for we must assert that little or nothing has been added to it) to the circumstances of the case.

40 Newton's experiments.

Newton himself, therefore, attempted to compare his propositions with experiment. Some were made by dropping balls from the dome of St Paul's cathedral; and all these showed as great a coincidence with his theory as they did with each other: but the irregularities were too great to allow him to say with precision what was the resistance. It appeared to follow the proportion of the squares of the velocities with sufficient exactness; and though he could not say that the resistance was equal to the weight of the column of air having the height necessary for communicating the velocity, it was always equal to a determinate part of it; and might be stated $= n a$, n being a number to be fixed by numerous experiments.

One great source of uncertainty in his experiments seems to have escaped his observation: the air in that dome is almost always in a state of motion. In the summer season there is a very sensible current of air downwards, and frequently in winter it is upwards: and this current bears a very great proportion to the velocity of the descents. Sir Isaac takes no notice of this.

He made another set of experiments with pendulums; and has pointed out some very curious and unexpected circumstances of their motions in a resisting medium. There is hardly any part of his noble work in which his address, his patience, and his astonishing penetration, appear in greater lustre. It requires the utmost intenseness of thought to follow him in these disquisitions; and we cannot enter on the subject at present: some notice will be taken of these experiments in the article *Resistance of Fluids*. Their results were much more uniform, and confirmed his general theory; and, as we have said above, it has been acquiesced in by the first mathematicians of Europe.

41 Inutility of the theory in practice.

But the deductions from this theory were so inconsistent with the observed motions of military projectiles, when the velocities are prodigious, that no application could be made which could be of any service for determining

42 The attempts of various mathematicians, &c.

mining the path and motion of cannon ſhot and bombs; and although Mr John Bernoulli gave in 1718 a moſt elegant determination of the trajectory and motion of a body projected in a fluid which reſiſts in the duplicate ratio of the velocities (a problem which even Newton did not attempt), it has remained a dead letter. Mr Benjamin Robins, equally eminent for phyſical ſcience and mathematical genius, was the firſt who ſuſpected the true cauſe of the imperfection of the uſually received theories; and in 1737 he publiſhed a ſmall tract, in which he ſhowed clearly, that even the Newtonian theory of reſiſtance muſt cauſe a cannon ball, diſcharged with a full allotment of powder, to deviate farther from the parabola, in which it would move *in vacuo*, than the parabola deviates from a ſtraight line. But he farther aſſerted, on the authority of good reaſoning, that in ſuch great velocities the reſiſtance muſt be much greater than this theory aſſigns; becauſe, beſides the reſiſtance ariſing from the *inertia* of the air which is put in motion by the ball, there muſt be a reſiſtance ariſing from a condenſation of the air on the anterior ſurface of the ball, and a rarefaction behind it: and there muſt be a third reſiſtance, ariſing from the ſtatical preſſure of the air on its anterior part, when the motion is ſo ſwift that there is a vacuum behind. Even theſe cauſes of diſagreement with the theory had been foreſeen and mentioned by Newton (ſee the Scholium to prop. 37, Book II. *Princip.*); but the ſubject ſeems to have been little attended to. The eminent mathematicians had few opportunities of making experiments; and the profeſſional men, who were in the ſervice of princes, and had their countenance and aid in this matter, were generally too deficient in mathematical knowledge to make a proper uſe of their opportunities. The numerous and ſplendid volumes which theſe gentlemen have been enabled to publiſh by the patronage of ſovereigns are little more than prolix extenſions of the ſimple theory of Galileo. Some of them, however, ſuch as St Remy, Antonini, and Le Blond, have given moſt valuable collections of experiments, ready for the uſe of the profound mathematician.

43 Obſervations of Mr Robins on velocity and reſiſtance,

Two or three years after this firſt publication, Mr Robins hit upon that ingenious method of meaſuring the great velocities of military projectiles, which has handed down his name to poſterity with great honour. And having aſcertained theſe velocities, he diſcovered the prodigious reſiſtance of the air, by obſerving the diminution of velocity which it occaſioned. This made him anxious to examine what was the real reſiſtance to any velocity whatever, in order to aſcertain what was the law of its variation; and he was equally fortunate in this attempt. His method of meaſuring the reſiſtance has been fully deſcribed in the article GUNNERY, n 9, &c.

It appears (Robins's *Math. Works*, vol. i. page 205.) that a ſphere of $4\frac{1}{2}$ inches in diameter, moving at the rate of $25\frac{1}{7}$ feet in a ſecond, ſuſtained a reſiſtance of 0,04914 pounds, or $\frac{4914}{100000}$ of a pound. This is a greater reſiſtance than that of the Newtonian theory, which gave $\frac{405755}{10000000}$ in the proportion of 1000 to 1211, or very nearly in the proportion of five to ſix in ſmall numbers. And we may adopt as a rule in all moderate velocities, that the reſiſtance to a ſphere is equal to $\frac{61}{100}$ of the weight of a column of air having the great circle of the ſphere for its baſe, and for its altitude the height through which a heavy body muſt fall *in vacuo* to acquire the velocity of projection.

This experiment is peculiarly valuable, becauſe the ball is preciſely the ſize of a 12 pound ſhot of caſt iron; and its accuracy may be depended on. There is but one ſource of error. The whirling motion muſt have occaſioned ſome whirl in the air, which would continue till the ball again paſſed through the ſame point of its revolution. The reſiſtance obſerved is therefore probably ſomewhat leſs than the true reſiſtance to the velocity of $25\frac{1}{7}$ feet, becauſe it was exerted in a relative velocity which was leſs than this, and is, in fact, the reſiſtance competent to this relative and ſmaller velocity.

44 And of Mr Rouſe and De Borda.

—Accordingly, Mr Smeaton, a moſt ſagacious naturaliſt, places great confidence in the obſervations of a Mr Rouſe of Leiceſterſhire, who meaſured the reſiſtance by the effect of the wind on a plane properly expoſed to it. He does not tell us in what way the velocity of the wind was aſcertained; but our deference for his great penetration and experience diſpoſes us to believe that this point was well determined. The reſiſtance obſerved by Mr Rouſe exceeds that reſulting from Mr Robins's experiments nearly in the proportion of 7 to 10.

45 They differ widely in their concluſions.

Chevalier de Borda made experiments ſimilar to thoſe of Mr Robins, and his reſults exceed thoſe of Robins in the proportion of 5 to 6. Theſe differences are ſo conſiderable, that we are at a loſs what meaſure to abide by. It is much to be regretted, that in a ſubject ſo intereſting both to the philoſopher and the man of the world, experiments have not been multiplied. Nothing would tend ſo much to perfect the ſcience of gunnery; and indeed till this be done, all the labours of mathematicians are of no avail. Their inveſtigations muſt remain an unintelligible cipher, till this key be ſupplied. It is to be hoped that Dr Charles Hutton of Woolwich, who has ſo ably extended Mr Robins's Examination of the Initial Velocities of Military Projectiles, will be encouraged to proceed to this part of the ſubject. We ſhould wiſh to ſee, in the firſt place, a numerous ſet of experiments for aſcertaining the reſiſtances in moderate velocities; and, in order to avoid all error from the reſiſtance and inertia of the machine, which is neceſſarily blended with the reſiſtance of the ball, in Mr Robins's form of the experiment, and is ſeparated with great uncertainty and riſk of error, we would recommend a form of experiment ſomewhat different.

46 A new form of experiment recommended.

Let the axis and arm which carries the ball be connected with wheelwork, by which it can be put in motion, and gradually accelerated. Let the ball be ſo connected with a bent ſpring, that this ſhall gradually compreſs it as the reſiſtance increaſes, and leave a mark of the degree of compreſſion; and let all this part of the apparatus be ſcreened from the air except the ball. The velocity will be determined preciſely by the revolutions of the arm, and the reſiſtance by the compreſſion of the ſpring. The beſt method would be to let this part of the apparatus be made to ſlide along the revolving arm, ſo that the ball can be made to deſcribe larger and larger circles. An intelligent mechanician will eaſily contrive an apparatus of this kind, held at any diſtance from the axis by a cord, which paſſes over a pulley in the axis itſelf, and is then brought along a perforation in the axis, and comes out at its extremity, where it is fitted with a ſwivel, to prevent it from ſnapping by being twiſted. Now let the machine be put in motion. The centrifugal force of the ball and apparatus will cauſe it to fly out as far as it is allowed by the cord;

and if the whole is put in motion by connecting it with ſome mill, the velocity may be moſt accurately aſcertained. It may alſo be fitted with a bell and hammer like Graveſande's machine for meaſuring centrifugal forces. Now by gradually veering off more cord, the diſtance from the centre, and conſequently the velocity and reſiſtance increaſe, till the hammer is diſengaged and ſtrikes the bell.

Another great advantage of this form of the experiment is, that the reſiſtance to very great velocities may be thus examined, which was impoſſible in Mr Robins's way. This is the great deſideratum, that we may learn in what proportion of the velocities the reſiſtances increaſe.

In the ſame manner, an apparatus, conſiſting of Dr Lynd's Anemometer, deſcribed in the article PNEUMATICS, n° 311, &c. might be whirled round with prodigious rapidity, and the fluid on it might be made clammy, which would leave a mark at its greateſt elevation, and thus diſcover the reſiſtance of the air to rapid motions.

Nay, we are of opinion that the reſiſtance to very rapid motions may be meaſured directly in the conduit pipe of ſome of the great cylinder bellows employed in blaſt furnaces: the velocity of the air in this pipe is aſcertained by the capacity of the cylinder and the ſtrokes of the piſton. We think it our duty to point out to ſuch as have the opportunities of trying them methods which promiſe accurate reſults for aſcertaining this moſt deſirable point.

47 The reſult of Robins's experiments as yet moſt to be depended on.

We are the more puzzled what meaſure to abide by, becauſe Mr Robins himſelf, in his Practical Propoſitions, does not make uſe of the reſult of his own experiments, but takes a much lower meaſure. We muſt content ourſelves, however, with this experimental meaſure, becauſe it is as yet the only one of which any account can be given, or well-founded opinion formed.

48 Applied to the formulæ.

Therefore, in order to apply our formulæ, we muſt reduce this experiment, which was made on a ball of $4\frac{1}{2}$ inches diameter, moving with the velocity of $25\frac{1}{5}$ feet per ſecond, to what would be the reſiſtance to a ball of one inch, having the velocity 1 foot. This will evidently give us $R = \frac{0{,}04914}{4{,}5^2 \times 25.2^2}$, being diminiſhed in the duplicate ratio of the diameter and velocity. This gives us R = 0,00000381973 pounds, or $\frac{3.81973}{1000000}$ of a pound. The logarithm is $\bar{4}$,58204. The reſiſtance here determined is the ſame whatever ſubſtance the ball be of; but the retardation occaſioned by it will depend on the proportion of the reſiſtance to the *vis inſita* of the ball; that is, to its quantity of motion. This in ſimilar velocities and diameters is as the denſity of the ball. The balls uſed in military ſervice are of caſt iron or of lead, whoſe ſpecific gravities are 7,207 and 11,37 nearly, water being 1. There is conſiderable variety in caſt iron, and this denſity is about the medium. Theſe data will give us

	For Iron.	For Lead.
W, or weight of a ball 1 inch in diameter - - lbs.	0,13648	0,21533
Log. of W - -	9.13509	9.33310
E' - - -	1116',6	1761'',6
Log. of E - -	3.04790	3.24591
u, or terminal velocity	189,03	237,43
Log. *u* - -	2.27653	2.37553
a, or producing height	558,3	880,8

Theſe numbers are of frequent uſe in all queſtions on this ſubject.

Mr Robins gives an expeditious rule for readily finding *a*, which he calls F (ſee the article GUNNERY), by which it is made 900 feet for a caſt iron ball of an inch diameter. But no theory of reſiſtance which he profeſſes to uſe will make this height neceſſary for producing the terminal velocity. His F therefore is an *empirical* quantity, analogous indeed to the producing height, but accommodated to his theory of the trajectory of cannon-ſhot, which he promiſed to publiſh, but did not live to execute. We need not be very anxious about this; for all our quantities change in the ſame proportion with R, and need only a correction by a multiplier or diviſor, when R ſhall be accurately eſtabliſhed.

We may illuſtrate the uſe of theſe formulæ by an example or two.

49 Examples of their uſe.

1. Then, to find the reſiſtance to a 24 pound ball moving with the velocity of 1670 feet in a ſecond, which is nearly the velocity communicated by 16 lbs. of powder. The diameter is 5,603 inches.

Log. R - -	+4.58204
Log. d^2 - -	+1.49674
Log. 1670^2 - -	+6.44548
Log. 334,4 lbs. = *r* -	2.52426

But it is found, by unequivocal experiments on the retardation of ſuch a motion, that it is 504 lbs. This is owing to the cauſes often mentioned, the additional reſiſtance to great velocities, ariſing from the condenſation of the air, and from its preſſure into the vacuum left by the ball.

2. Required the terminal velocity of this ball?

Log. R - -	+4.58204
Log. d^2 - -	+1.49674
Log. reſiſt. to veloc. 1 -	6.07878 = *a*
Log. W - -	1.38021 = *b*
Diff. of *a* and *b*, = log u^2 -	5.30143
Log. 447,4 = *u* -	2.65071

50 Table of terminal velocity according to Newton and Robins.

As the terminal velocity *u*, and its producing height *a*, enter into all computations of military projectiles, we have inſerted the following Table for the uſual ſizes of cannon-ſhot, computed both by the Newtonian theory of reſiſtance, and by the reſiſtances obſerved in Robins's experiments.

Lb. Ball.	Newton.		Robins.		Diam. Inch.
	u Term. Vel.	2 *a*.	Term. Vel.	2 *a*.	
1	289,9	2626,4	263,4	2168,6	1,94
2	324,9	3298,5	295,2	2723,5	2,45
3	348,2	3788,2	316,4	3127,9	2,80
4	365,3	4170,3	331,9	3442,6	3,08
6	390,8	4472,7	355,1	3940,7	3,52
9	418,1	5463,5	379,9	4511,2	4,04
12	438,6	6010,6	398,5	4962,9	4,45
18	469,3	6883,3	426,5	5683,5	5,09
24	492,4	7576,3	447,4	6255,7	5,61
32	512,6	8024,8	465,8	6780,4	6,21
	540,5	9129,9	491,5	7538,3	6,75

Mr Muller, in his writings on this ſubject, gives a much

51 Mr Muller's theory altogether erroneous.

much ſmaller meaſure of reſiſtance, and conſequently a much greater terminal velocity: but his theory is a miſtake from beginning to end (See his *Supplement* to his *Treatiſe of Artillery*, art. 150, &c.) In art. 148. he aſſumes an algebraic expreſſion for a principle of mechanical argument; and from its conſequence draws erroneous concluſions. He makes the reſiſtance of a cylinder $\frac{1}{3}$ leſs than Newton *ſuppoſes* it; and his reaſon is falſe. Newton's meaſure is demonſtrated by his commentators Le Seur and Jaquier to be even a little too ſmall, upon his own principles, (Not. 277. Prop. 36. B. II.) Mr Muller then, without any ſeeming reaſon, introduces a new principle, which he makes the chief ſupport of his theory, in oppoſition to the theories of other mathematicians. The principle is falſe, and even abſurd, as we ſhall have occaſion to ſhow by and by. In conſequence, however, of this principle, he is enabled to compare the reſults with many experiments, and the agreement is very flattering. But we ſhall ſoon ſee that little dependence can be had on ſuch compariſons. We notice theſe things here, becauſe Mr Muller being head of the artillery ſchool in Britain, his publications have become a ſort of text-books. We are miſerably deficient in works on this ſubject, and muſt have recourſe to the foreign writers.

52 The motions conſidered through their whole courſe.

We now proceed to conſider theſe motions through their whole courſe: and we ſhall firſt conſider them as affected by the reſiſtance only; then we ſhall conſider the perpendicular aſcents and deſcents of heavy bodies through the air; and, laſtly, their motion in a curvilineal trajectory, when projected obliquely. This muſt be done by the help of the abſtruſer parts of fluxionary mathematics. To make it more perſpicuous, we ſhall, by way of introduction, conſider the ſimply reſiſted rectilineal motions geometrically, in the manner of Sir Iſaac Newton. As we advance, we ſhall quit this track, and proſecute it algebraically, having by this time acquired diſtinct ideas of the algebraic quantities.

53 Preliminary obſervations.

We muſt keep in mind the fundamental theorems of varied motions.

1. The momentary variation of the velocity is proportional to the force and the moment of time jointly, and may therefore be repreſented by $\pm\dot{v} = f\dot{t}$, where $\dot{v}$ is the momentary increment or decrement of the velocity v, f the accelerating or retarding force, and $\dot{t}$ the moment or increment of the time t.

2. The momentary variation of the ſquare of the velocity is as the force, and as the increment or decrement of the ſpace jointly; and may be repreſented by $\pm v\dot{v} = f\dot{s}$. The firſt propoſition is familiarly known. The ſecond is the 39th of Newton's *Principia*, B. I. It is demonſtrated in the article OPTICS, p. 281. and is the moſt extenſively uſeful propoſition in mechanics.

54 The motions as affected by reſiſtance only. Plate CCCCXVII.

Theſe things being premiſed, let the ſtraight line AC (fig. 6.) repreſent the initial velocity V, and let CO, perpendicular to AC, be the time in which this velocity would be extinguiſhed by the uniform action of the reſiſtance. Draw through the point A an equilateral hyperbola A e B, having OF, OCD for its aſſymptotes; then let the time of the reſiſted motion be repreſented by the line CB, C being the firſt inſtant of the motion. If there be drawn perpendicular ordinates xe, gf, DB, &c. to the hyperbola, they will be proportional to the velocities of the body at the inſtants x, g, D, &c. and the hyperbolic areas ACxe, ACgf, ACDB, &c. will be proportional to the ſpaces deſcribed during the times Cx, Cg, CB, &c.

For, ſuppoſe the time divided into an indefinite number of ſmall and equal moments, Cc, Dd, &c. draw the ordinates ac, bd, and the perpendiculars $b\beta$, $a\alpha$. Then, by the nature of the hyperbola, AC : ac = Oc : OC; and AC—ac : ac = Oc—OC : OC, that is, Ax : ac = Cc : OC, and Aα : Cc = ac : OC, = AC·ac : AC·OC; in like manner, Bβ : Dd = BD·bD : BD·OD. Now Dd = Cc, becauſe the moments of time were taken equal, and the rectangles AC·CO, BD·DO, are equal, by the nature of the hyperbola; therefore Aα : Bβ = AC·ac : BD·bd: but as the points c, d continually approach, and ultimately coincide with C, D, the ultimate ratio of AC·ac to BD·bd is that of AC^2 to BD^2; therefore the momentary decrements of AC and BD are as AC^2 and BD^2. Now, becauſe the reſiſtance is meaſured by the momentary diminution of velocity, theſe diminutions are as the ſquares of the velocities; therefore the ordinates of the hyperbola and the velocities diminiſh by the ſame law; and the initial velocity was repreſented by AC: therefore the velocities at all the other inſtants x, g, D, are properly repreſented by the correſponding ordinates. Hence,

1. Since the abſciſſæ of the hyperbola are as the times, and the ordinates are as the velocities, the areas will be as the ſpaces deſcribed, and ACxe is to Acgf as the ſpace deſcribed in the time Cx to the ſpace deſcribed in the time Cg (1ſt Theorem on varied motions).

2. The rectangle ACOF is to the area ACDB as the ſpace formerly expreſſed by $2a$, or E to the ſpace deſcribed in the reſiſting medium during the time CD: for AC being the velocity V, and OC the extinguiſhing time t, this rectangle is $= tV$, or E, or $2a$, of our former diſquiſitions; and becauſe all the rectangles, ſuch as ACOF, BDOG, &c. are equal, this correſponds with our former obſervation, that the ſpace uniformly deſcribed with any velocity during the time in which it would be uniformly extinguiſhed by the correſponding reſiſtance is a conſtant quantity, viz. that in which we always had $tv = E$, or $2a$.

3. Draw the tangent Ax; then, by the hyperbola Cx = CO: now Cx is the time in which the reſiſtance to the velocity AC would extinguiſh it; for the tangent coinciding with the elemental arc Aa of the curve, the firſt impulſe of the uniform action of the reſiſtance is the ſame with the firſt impulſe of its varied action. By this the velocity AC is reduced to ac. If this operated uniformly like gravity, the velocities would diminiſh uniformly, and the ſpace deſcribed would be repreſented by the triangle ACx.

This triangle, therefore, repreſents the height thro' which a heavy body muſt fall in vacuo, in order to acquire the terminal velocity.

4. The motion of a body reſiſted in the duplicate ratio of the velocity will continue without end, and a ſpace will be deſcribed which is greater than any aſſignable ſpace, and the velocity will grow leſs than any that can be aſſigned; for the hyperbola approaches continually to the aſſymptote, but never coincides with it. There is no velocity BD ſo ſmall, but a ſmaller ZP will be found beyond it; and the hyperbolic ſpace

may be continued till it exceeds any ſurface that can be aſſigned.

5. The initial velocity AC is to the final velocity BD as the ſum of the extinguiſhing time and the time of the retarded motion, is to the extinguiſhing time alone: for AC : BD = OD (or OC + CD) : OC; or $V : v = e : e + t$.

6. The extinguiſhing time is to the time of the retarded motion as the final velocity is to the velocity loſt during the retarded motion: for the rectangles AFOC, BDOG are equal; and therefore AVGF and BVCD are equal. and VC : VA = VG : VB; therefore $t = e\frac{V-v}{v}$, and $e = t\frac{v}{V-v}$.

7. Any velocity is reduced in the proportion of m to n in the time $e\frac{m-n}{n}$. For, let AC : BD = $m : n$; then DO : CO = $m : n$, and DC : CO = $m - n : n$, and $DC = \frac{m-n}{n}CO$, or $t = e\frac{m-n}{n}$. Therefore any velocity is reduced to one half in the time in which the initial reſiſtance would have extinguiſhed it by its uniform action.

55 Another mode of determining this motion.

Thus may the chief circumſtances of this motion be determined by means of the hyperbola, the ordinates and abſciſſæ exhibiting the relations of the times and velocities, and the areas exhibiting the relations of both to the ſpaces deſcribed. But we may render the conception of theſe circumſtances infinitely more eaſy and ſimple, by expreſſing them all by lines, inſtead of this combination of lines and ſurfaces. We ſhall accompliſh this purpoſe by conſtructing another curve LKP, having the line ML, parallel to OD for its abſciſſa, and of ſuch a nature, that if the ordinates to the hyperbola AC, ex, fg, BD, &c. be produced till they cut this curve in L, p, n, K, &c. and the abſciſſa in L, i, h, s, &c. the ordinates ip, hn, sK, &c. may be proportional to the hyperbolic areas $eAcx$, $fAcg$, sAcK. Let us examine what kind of curve this will be.

Make OC : Ox = Oe : Og; then (Hamilton's *Conics*, IV. 14. Cor.), the areas ACxe, $exgf$ are equal: therefore drawing ps, nt perpendicular to OM, we ſhall have (by the aſſumed nature of the curve LpK), $Ms = st$; and if the abſciſſa OD be divided into any number of ſmall parts in geometrical progreſſion (reckoning the commencement of them all from O), the axis Vi of this curve will be divided by its ordinates into the ſame number of equal parts; and this curve will have its ordinates LM, ps, nt, &c. in geometrical progreſſion, and its abſciſſæ in arithmetical progreſſion.

Alſo, let KN, MV touch the curve in K and L, and let OC be ſuppoſed to be to Oc, as OD to Od, and therefore Cc to Dd as OC to OD; and let theſe lines Cc, Dd be indefinitely ſmall; then (by the nature of the curve) Lo is equal to Kr: for the areas $aACc$, $bBDd$ are in this caſe equal. Alſo lo is to kr, as LM to KI, becauſe $cC : dD = CO : DO$:

Therefore IN : IK = $rK : rk$
IK : ML = $rk : ol$
ML : MV = $ol : o$L
and IN : MN = $rK : o$L.

That is, the ſubtangent IN, or MV, is of the ſame magnitude, or is a conſtant quantity in every part of the curve.

Laſtly, the ſubtangent IN, correſponding to the point K of the curve, is to the ordinate Ks as the rectangle BDOG or ACOF to the parabolic area BDCA.

For let $fgbn$ be an ordinate very near to BDsK; and let bn cut the curve in n, and the ordinate KI in q; then we have

Kq : qn = KI : IN, or
Dg : qn = DO : IN;
but BD : AC = CO : DO;
therefore BD . Dg : AC . qn = CO : IN:

Therefore the ſum of all the rectangles BD.Dg is to the ſum of all the rectangles AC . qn, as CO to IN; but the ſum of the rectangles BD . Dg is the ſpace ACDB; and, becauſe AC is given, the ſum of the rectangles AC . qn is the rectangle of AC and the ſum of all the lines qn; that is, the rectangle of AC and RL: therefore the ſpace ACDB : AC . RL = CO : IN, and ACDB × IN = AC . CO . RL; and therefore IN : RL = AC . CO : ACDB.

Hence it follows that QL expreſſes the area BVA, and, in general, that the part of the line parallel to OM, which lies between the tangent KN and the curve LpK, expreſſes the correſponding area of the hyperbola which lies without the rectangle BDOG.

And now, by the help of this curve, we have an eaſy way of conceiving and computing the motion of a body through the air. For the ſubtangent of our curve now repreſents twice the height through which the ball muſt fall in vacuo, in order to acquire the terminal velocity; and therefore ſerves for a ſcale on which to meaſure all the other repreſentatives of the motion.

56 The whole reduced to ſimple arithmetical computation.

But it remains to make another obſervation on the curve LpK, which will ſave us all the trouble of graphical operations, and reduce the whole to a very ſimple arithmetical computation. It is of ſuch a nature, that when MI is conſidered as the abſciſſa, and is divided into a number of equal parts, and ordinates are drawn from the points of diviſion, the ordinates are a ſeries of lines in geometrical progreſſion, or are continual proportionals. Whatever is the ratio between the firſt and ſecond ordinate, there is the ſame between the ſecond and third, between the third and fourth, and ſo on; therefore the number of parts into which the abſciſſa is divided is the number of theſe equal ratios which is contained in the ratio of the firſt ordinate to the laſt: For this reaſon, this curve has got the name of the *logiſtic* or *logarithmic* curve; and it is of immenſe uſe in the modern mathematics, giving us the ſolution of many problems in the moſt ſimple and expeditious manner, on which the genius of the ancient mathematicians had been exerciſed in vain. Few of our readers are ignorant, that the numbers called *logarithms* are of equal utility in arithmetical operations, enabling us not only to ſolve common arithmetical problems with aſtoniſhing diſpatch, but alſo to ſolve others which are quite inacceſſible in any other way. Logarithms are nothing more than the numerical meaſures of the abſciſſa of this curve, correſponding to ordinates, which are meaſured on the ſame or any other ſcale by the natural numbers; that is, if MLs be divided into equal parts, and from the points of diviſion lines be drawn parallel to

MI, cutting the curve L p K, and from the points of interſection ordinates be drawn to MI, theſe will divide MI into portions, which are in the ſame proportion to the ordinates that the logarithms bear to their natural numbers.

In conſtructing this curve we were limited to no particular length of the line LR, which repreſented the ſpace ACDB; and all that we had to take care of was, that when OC, O s, O g were taken in geometrical progreſſion, M s, M t ſhould be in arithmetical progreſſion. The abſciſſæ having ordinates equal to $p\,s$, $n\,t$, &c. might have been twice as long, as is ſhown in the dotted curve which is drawn through L. All the lines which ſerve to meaſure the hyperbolic ſpaces would then have been doubled. But NI would alſo have been doubled, and our proportions would have ſtill held good; becauſe this ſubtangent is the ſcale of meaſurement of our figure, as E or $2\,a$ is the ſcale of meaſurement for the motions.

Since then we have tables of logarithms calculated for every number, we may make uſe of them inſtead of this geometrical figure, which ſtill requires conſiderable trouble to ſuit it to every caſe. There are two ſets of logarithmic tables in common uſe. One is called a table of hyperbolic or natural logarithms. It is ſuited to ſuch a curve as is drawn in the figure, where the ſubtangent is equal to that ordinate $\tau\upsilon$ which correſponds to the ſide πO of the ſquare $\pi\theta\lambda$O inſerted between the hyperbola and its aſſymptotes. This ſquare is the unit of ſurface, by which the hyperbolic areas are expreſſed; its ſide is the unit of length, by which the lines belonging to the hyperbola are expreſſed; $\tau\upsilon$ is = 1, or the unit of numbers to which the logarithms are ſuited, and then IN is alſo 1. Now the ſquare $\theta\pi$Oλ being unity, the area BACD will be ſome number; πO being alſo unity, OD is ſome number: Call it x. Then, by the nature of the hyperbola, OB : Oπ = $\pi\theta$: DB: That is, $x : 1 = 1 : \frac{1}{x}$, ſo that DB is $\frac{1}{x}$. Now calling Dd $\dot{x}$, the area BD $d\,b$, which is the fluxion (ultimately) of the hyperbolic area, is $\frac{\dot{x}}{x}$. Now in the curve LpK, MI has the ſame ratio to NI that BACD has to $\theta\lambda$Oπ: Therefore, if there be a ſcale of which NI is the unit, the number on this ſcale correſponding to MI has the ſame ratio to 1 which the number meaſuring BACD has to 1; and I i, which correſponds to BD $d\,b$, is the fluxion (ultimately) of MI: Therefore, if MI be called the logarithm of x, $\frac{\dot{x}}{x}$ is properly repreſented by the fluxion of MI. In ſhort, the line MI is divided preciſely as the line of numbers on a Gunter's ſcale, which is therefore a line of logarithms; and the numbers called logarithms are juſt the lengths of the different parts of this line meaſured on a ſcale of equal parts. Therefore, when we meet with ſuch an expreſſion as $\frac{\dot{x}}{x}$ viz. the fluxion of a quantity divided by the quantity itſelf, we conſider it as the fluxion of the logarithm of that quantity, becauſe it is really ſo when the quantity is a number; and it is therefore ſtrictly true that the fluent of $\frac{\dot{x}}{x}$ is the hyperbolic logarithm of x.

Certain reaſons of convenience have given riſe to another ſet of logarithms; theſe are ſuited to a logiſtic curve whoſe ſubtangent is only $\frac{43429}{100000}$ of the ordinate $r\upsilon$, which is equal to the ſide of the hyperbolic ſquare, and which is aſſumed for the unit of number. We ſhall ſuit our applications of the preceding inveſtigation to both theſe, and ſhall firſt uſe the common logarithms whoſe ſubtangent is 0,43429.

57 Illuſtrated by examples.

The whole ſubject will be beſt illuſtrated by taking an example of the different queſtions which may be propoſed.

Recollect that the rectangle ACOF is $= 2a$, or $\frac{u^2}{g}$, or E, for a ball of caſt-iron one inch diameter, and if it has the diameter d, it is $\frac{u^2 d}{g}$, or $2ad$, or Ed.

I. It may be required to determine what will be the ſpace deſcribed in a given time t by a ball ſetting out with a given velocity V, and what will be its velocity v at the end of that time.

Here we have NI : MI = ACOF : BDCA; now NI is the ſubtangent of the logiſtic curve; MI is the difference between the logarithms of OD and OC; that is, the difference between the logarithms of $e+t$ and e; ACOF is $2ad$, or $\frac{u^2 d}{g}$, or Ed.

Therefore by common logarithms 0,43429 : log. $\overline{e+t}$ — log. $e = 2ad$: S, = ſpace deſcribed,

or 0,43429 : log. $\frac{e+t}{e} = 2ad$: S,

and S. $= \frac{2ad}{0,43429} \times$ log. $\frac{e+t}{e}$,

by hyperbolic logarithms S $= 2ad \times$ log. $\frac{e+t}{e}$.

Let the ball be a 12 pounder, and the initial velocity be 1600 feet, and the time 20 ſeconds. We muſt firſt find e, which is $\frac{2ad}{V}$.

Therefore, log. $2a$ - -	+	3.03236
log. d (4, 5) -	+	0.65321
log. V. (1600) -	—	3.20412
Log. of 3″,03, = e - -		0.48145
And $e+t$ is 23″,03, of which the log. is		1.36229
from which take the log. of e -		0.48145
remains the log. of $\frac{e+t}{e}$ - -		0.88084

This muſt be conſidered as a common number by which we are to multiply $\frac{2ad}{0,43429}$.

Therefore add the logarithms of $2ad$	+	3.68557
log. $\frac{e+t}{e}$ -	+	9.94490
log. 0,43429 -	—	9.63778
Log. S. 9833 feet - -		3.99269

For the final velocity,

OD : OC = AC : BD, or $e+t : e = V : v$.

23″,03 : 3″,03 = 1600 : 210$\frac{1}{2}$, = v.

The ball has therefore gone 3278 yards, and its velocity is reduced from 1600 to 210.

It

It may be agreeable to the reader to see the gradual progress of the ball during some seconds of its motion.

T.	*S.*	*Diff.*	*V.*	*Diff.*
1″	1383		1203	397
2″	2456	1073	964	239
3″	3336	880	804	160
4″	4080	744	690	114
5″	4725	645	604	86
6″	5294	569	537	67

The first column is the time of the motion, the second is the space described, the third is the differences of the spaces, showing the motion during each successive second; the fourth column is the velocity at the end of the time t; and the last column is the differences of velocity, showing its diminution in each successive second. We see that at the distance of 1000 yards the velocity is reduced to one half, and at the distance of less than a mile it is reduced to one third.

II. It may be required to determine the distance at which the initial velocity V is reduced to any other quantity v. This question is solved in the very same manner, by substituting the logarithms of V and v for those of $e+t$ and e; for AC : BD = OD : OC, and therefore log. $\frac{AC}{BD}$ = log. $\frac{OD}{OC}$, or log. $\frac{V}{v}$ = log. $\frac{e+t}{e}$.

Thus it is required to determine the distance in which the velocity 1780 of a 24 pound ball (which is the medium velocity of such a ball discharged with 16 pounds of powder) will be reduced to 1500.

Here d is 5,68, and therefore the logarithm of $2ad$ is - - +3.78671

Log. $\frac{V}{v}$ = 0,07433, of which the log. is +8.87116

Log. 0,43429 - - −9.63778

Log. 1047,3 feet, or 349 yards 3.02009

This reduction will be produced in about $\frac{7}{8}$ of a second.

III. Another question may be to determine the time which a ball, beginning to move with a certain velocity, employs in passing over a given space, and the diminution of velocity which it sustains from the resistance of the air.

We may proceed thus:

$2ad$: S = 0,43429 : log. $\frac{e+t}{e}$, = t. Then to log. $\frac{e+t}{e}$ add log. e and we obtain log. $e+t$, and $e+t$; from which if we take e we have t. Then to find v, say $e+t : e = V : v$.

58 Application of an experiment of Mr Robins. See *Robins's Math. Works*, vol. i. p. 135.

We shall conclude these examples by applying this last rule to Mr Robins's experiment on a musket bullet of $\frac{1}{4}$ of an inch in diameter, which had its velocity reduced from 1670 to 1425 by passing through 100 feet of air. This we do in order to discover the resistance which it sustained, and compare it with the resistance to a velocity of 1 foot *per* second.

We must first ascertain the first term of our analogy. The ball was of lead, and therefore $2a$ must be multiplied by d and by m, which expresses the ratio of the density of lead to that of cast iron. d is 0,75, and m is $\frac{11,37}{7,21}$ = 1,577. Therefore

log.	$2a$	3.03236
	d	9.87506
	m	0.19782
Log.	$2adm$	3.10524

and $2adm$ = 1274,2.

Now 1274,2 : 100 = 0,43429 : 0,03408 = log. $\frac{e+t}{e}$.

But $e = \frac{2adm}{V}$ = 0,763, and its logarithm = 9.88252, which, added to 0.03408, gives 9.91660, which is the log. of $e+t$, = 0,825, from which take e, and there remains t =, 0″,062, or $\frac{62}{1000}$ of a second, for the time of passage. Now, to find the remaining velocity, say 825 :,763 = 1670 : 1544, = v.

But in Mr Robins's experiment the remaining velocity was only 1425, the ball having lost 245; whereas by this computation it should have lost only 126. It appears, therefore, that the resistance is double of what it would have been if the resistance increased in the duplicate proportion of the velocity. Mr Robins says it is nearly triple. But he supposes the resistance to slow motions much smaller than his own experiment, so often mentioned, fully warrants.

The time e, in which the resistance of the air would extinguish the velocity is 0″,763. Gravity, or the weight of the bullet, would have done it in $\frac{1670}{32}$ or 52″; therefore the resistance is $\frac{52}{0,763}$ times, or nearly 68 times its weight, by this theory, or 5,97 pounds. If we calculate from Mr Robins's experiment, we must say log. $\frac{V}{v}$: 0,43429 = 100 : e V, which will be 630,23, and $e = \frac{630,23}{1670}$ = 0″,3774, and $\frac{52}{0,3774}$ gives 138 for the proportion of the resistance to the weight, and makes the resistance 12,07 pounds, fully double of the other.

It is to be observed, that with this velocity, which greatly exceeds that with which the air can rush into a void, there must be a statical pressure of the atmosphere equal to $6\frac{1}{4}$ pounds. This will make up the difference, and allows us to conclude that the resistance arising solely from the motion communicated to the air follows very nearly the duplicate proportion of the velocity.

The next experiment, with a velocity of 1690 feet, gives a resistance equal to 157 times the weight of the bullet, and this bears a much greater proportion to the former than 1690 does to 1670²; which shows, that although these experiments clearly demonstrate a prodigious augmentation of resistance, yet they are by no means susceptible of the precision which is necessary for discovering the law of this augmentation, or for a good foundation of practical rules; and it is still greatly to be wished that a more accurate mode of investigation could be discovered.

59 Recapitulation.

Thus we have explained, in great detail, the principles and the process of calculation for the simple case

of the motion of projectiles through the air. The learned reader will think that we have been unreasonably prolix, and that the whole might have been comprised in less room, by taking the algebraic method. We acknowledge that it might have been done even in a few lines. But we have observed, and our observation has been confirmed by persons well versed in such subjects, that in all cases where the fluxionary process introduces the fluxion of a logarithm, there is a great want of distinct ideas to accompany the hand and eye. The solution comes out by a sort of magic or legerdemain, we cannot tell either *how* or *why*. We therefore thought it our duty to furnish the reader with distinct conceptions of the things and quantities treated of. For this reason, after showing, in Sir Isaac Newton's manner, how the spaces described in the retarded motion of a projectile followed the proportion of the hyperbolic areas, we shewed the nature of another curve, where lines could be found which increase in the very same manner as the path of the projectile increases; so that a point describing the abscissa MI of this curve moves precisely as the projectile does. Then, discovering that this line is the same with the line of logarithms on a Gunter's scale, we shewed how the logarithm of a number really represents the path or space described by the projectile. And we were the more disposed to do this, because in the articles LOGARITHMS and *LOGARITHMIC Curve*, there has not been that notice taken of it which would have been proper.

Having thus, we hope, enabled the reader to conceive distinctly the quantities employed, we shall leave the geometrical method, and prosecute the rest of the subject in a more compendious manner.

60 **Of the perpendicular ascents of heavy projectiles.**

We are, in the next place, to consider the perpendicular ascents and descents of *heavy* projectiles, where the resistance of the air is combined with the action of gravity: and we shall begin with the descents.

Let u, as before, be the terminal velocity, and g the accelerating power of gravity: When the body moves with the velocity u, the resistance is equal to g; and in every other velocity v, we must have $u^2 : v^2 = g : \frac{g v^2}{u^2}, = r$, for the resistance to that velocity. In the descent the body is urged by gravity g, and opposed by the resistance $\frac{g v^2}{u^2}$: therefore the remaining accelerating force, which we shall call f, is $g - \frac{g v^2}{u^2}$, or $\frac{g u^2 - g v^2}{u^2}$, or $\frac{g (u^2 - v^2)}{u^2}, = f$.

Now the fundamental theorem for varied motions is $f \dot{s} = u \dot{v}$, and $\dot{s} = \frac{v \dot{v}}{f}, = \frac{u^2}{g} \times \frac{\dot{v} v}{u^2 - v^2}$, and $s = \frac{u^2}{g} \times f \frac{\dot{v} v}{u^2 - v^2} + C$. Now the fluent of $\frac{\dot{v} v}{u^2 - v^2}$ is $=$ — hyperb. log of $\sqrt{u^2 - v^2}$. For the fluxion of $\sqrt{u^2 - v^2}$ is $\frac{-\dot{v} v}{\sqrt{u^2 - v^2}}$, and this divided by the quantity $\sqrt{u^2 - v^2}$, of which it is the fluxion, gives precisely $\frac{\dot{v} v}{u^2 - v^2}$, which is therefore the fluxion of its hyperbolic logarithm. Therefore $S = - \frac{u^2}{g} \times L \sqrt{u^2 - v^2} + C$. Where L means the hyperbolic logarithm of the quantity annexed to it, and λ may be used to express its common logarithm. (See article FLUXIONS).

The constant quantity C for completing the fluent is determined from this consideration, that the space described is o, when the velocity is o: therefore $C - \frac{u^2}{g} \times L \sqrt{u^2} = o$, and $C = \frac{u^2}{g} \times L \sqrt{u^2}$, and the complete fluent $S = \frac{u^2}{g} \times L \sqrt{u^2} - L \sqrt{u^2 - v^2}$,

$= \frac{u^2}{g} \times L \sqrt{\frac{u^2}{u^2 - v^2}}. = \frac{u^2}{0{,}43429\, g} \times \lambda \sqrt{\frac{u^2}{u^2 - v^2}}$,

or (putting M for 0,43429, the modulus or subtangent of the common logistic curve) $= \frac{u^2}{M g} \times \lambda \sqrt{\frac{u^2}{u^2 - v^2}}$.

This equation establishes the relation between the space fallen through, and the velocity acquired by the fall. We obtain by it $\frac{g S}{u^2} = L \sqrt{\frac{u^2}{u^2 - v^2}}$, and $\frac{2 g S}{u^2} = L \cdot \frac{u^2}{u^2 - v^2}$, or, which is still more convenient for us, $\frac{M \times 2 g S}{u^2} = \lambda \frac{u^2}{u^2 - v^2}$, that is, equal to the logarithm of a certain number: therefore having found the natural number corresponding to the fraction $\frac{M \times 2 g S}{u^2}$, consider it as a logarithm, and take out the number corresponding to it: call this n. Then, since n is equal to $\frac{u^2}{u^2 - v^2}$, we have $n u^2 - n v^2 = u^2$, and $n u^2 - u^2 = n v^2$, or $n v^2 = u^2 \times \overline{n - v}$, and $v^2 = \frac{u^2 \times \overline{n - 1}}{n}$.

To expedite all the computations on this subject, it will be convenient to have multipliers ready computed for $M \times 2 g$, and its half,

viz.	27,794, whose log. is -	1.44396
and	13,897 - - -	1.14293

But v may be found much more expeditiously by observing that $\sqrt{\frac{u^2}{u^2 - v^2}}$ is the secant of an arch of a circle whose radius is u, and whose sine is v, or whose radius is unity and sine $= \frac{v}{u}$: therefore, considering the above fraction as a logarithmic secant, look for it in the tables, and then take the sine of the arc of which this is the secant, and multiply it by u; the product is the velocity required.

We shall take an example of a ball whose terminal velocity is $689\frac{1}{3}$ feet, and ascertain its velocity after a fall of 1848 feet. Here,

$u^2 = 475200$	and its log. -	$= 5.67688$
$u = 689\frac{1}{3}$	- -	2.83844
$g = 32$	- -	1.50515
$S = 1848$	- -	3.26670

Then

Then log. 27,794	- -	+ 1.44396
log. S	- -	+ 3.26670
log. u^2	- -	— 5.67688

Log. of 0,10809 = log. n - 9.03378

0,10809 is the logarithm of 1,2826 = n, and $n-1$ = 0,2826, and $\frac{u^2 \times n-1}{n} = 323,6^2$, $= v^2$, and $v =$ 323,6.

In like manner, 0,054045 (which is half of 0,10809) will be found to be the logarithmic ſecant of 28°, whoſe ſine 0,46947 multiplied by $689\frac{1}{3}$ gives 324 for the velocity.

The proceſs of this ſolution ſuggeſts a very perſpicuous manner of conceiving the law of deſcent; and it may be thus expreſſed:

M is to the logarithm of the ſecant of an arch whoſe ſine is $\frac{v}{u}$, and radius 1, as $2a$ is to the height through which the body muſt fall in order to acquire the velocity v. Thus, to take the ſame example.

1. Let the height h be ſought which will produce the velocity 323,62, the terminal velocity of the ball being 689,34. Here $2a$, or $\frac{u^2}{g}$ is 14850, and $\frac{323,62}{689,34} =$ 0,46947, which is the ſine of 28°. The logarithmic ſecant of this arch is 0,05407. Now M or 0,43429 : 0,05407 = 14850 : 1848, the height wanted.

2. Required the velocity acquired by the body by falling 1848 feet. Say 14850 : 1848 = 0,43429 : 0,05407. Look for this number among the logarithmic ſecants. It will be found at 28°, of which the logarithmic ſine is - - - 9.67161

Add to this the log. of u - - 2.83844

The ſum - - - 2.51005

is the logarithm of 323,62, the velocity required.

We may obſerve, from theſe ſolutions, that the acquired velocity continually approaches to, but never equals, the terminal velocity. For it is always expreſſed by the ſine of an arch of which the terminal velocity is the radius. We cannot help taking notice here of a very ſtrange aſſertion of Mr Muller, late profeſſor of mathematics and director of the royal academy at Woolwich. He maintains, in his Treatiſe on Gunnery, his Treatiſe of Fluxions, and in many of his numerous works, that a body cannot poſſibly move through the air with a greater velocity than this; and he makes this a fundamental principle, on which he eſtabliſhes a theory of motion in a reſiſting medium, which he aſſerts with great confidence to be the only juſt theory; ſaying, that all the inveſtigations of Bernoulli, Euler, Robins, Simpſon, and others, are erroneous. We uſe this ſtrong expreſſion, becauſe, in his criticiſms on the works of thoſe celebrated mathematicians, he lays aſide good manners, and taxes them not only with ignorance, but with diſhoneſty; ſaying, for inſtance, that it required no ſmall dexterity in Robins to confirm by his experiments a theory founded on falſe principles; and that Thomas Simpſon, in attempting to conceal his obligations to him for ſome valuable propoſitions, by changing their form, had ignorantly fallen into groſs errors.

61 Erroneous aſſertion of Mr Muller.

Nothing can be more palpably abſurd than this aſſertion of Mr Muller. A blown bladder will have but a ſmall terminal velocity; and when moving with this velocity, or one very near it, there can be no doubt that it will be made to move much ſwifter by a ſmart ſtroke. Were the aſſertion true, it would be impoſſible for a portion of air to be put into motion through the reſt, for its terminal velocity is nothing. Yet this author makes this aſſertion a principle of argument, ſaying, that it is impoſſible that a ball can iſſue from the mouth of a cannon with a greater velocity than this; and that Robins and others are groſsly miſtaken, when they give them velocities three or four times greater, and reſiſtances which are 10 or 20 times greater than is poſſible; and by thus compenſating his ſmall velocities by ſtill ſmaller reſiſtances, he confirms his theory by many experiments adduced in ſupport of the others. No reaſon whatever can be given for the aſſertion. Newton, or perhaps Huygens, was the firſt who obſerved that there was a limit to the velocity which gravity could communicate to a body; and this limit was found by his commentators to be a term to which it was vaſtly convenient to refer all its other motions. It therefore became an object of attention; and Mr Muller, through inadvertency, or want of diſcernment, has fallen into this miſtake, and with that arrogance and ſelf-conceit which mark all his writings, has made this miſtake a fundamental principle, becauſe it led him to eſtabliſh a novel ſet of doctrines on this ſubject. He was fretted at the ſuperior knowledge and talents of Mr Simpſon, his inferior in the academy, and was guilty of ſeveral mean attempts to hurt his reputation. But they were unſucceſsful.

62 Motion of a body projected downwards.

We might proceed to conſider the motion of a body projected downwards. While the velocity of projection is leſs than the terminal velocity, the motion is determined by what we have already ſaid: for we muſt compute the height neceſſary for acquiring this velocity in the air, and ſuppoſe the motion to have begun there. But if the velocity of projection be greater, this method fails. We paſs it over (though not in the leaſt more difficult than what has gone before), becauſe it is of mere curioſity, and never occurs in any intereſting caſe. We may juſt obſerve, that ſince the motion is ſwifter than the terminal velocity, the reſiſtance muſt be greater than the weight, and the motion will be retarded. The very ſame proceſs will give us for the ſpace deſcribed $S = \frac{u^2}{g} \times L \sqrt{\frac{V^2 - u^2}{v^2 - u^2}}$, V being the velocity of projection, greater than u. Now as this ſpace evidently increaſes continually (becauſe the body always falls), but does not become infinite in any finite time, the fraction $\frac{V^2 - u^2}{v^2 - u^2}$ does not become infinite; that is, v^2 does not become equal to u^2: therefore although the velocity V is continually diminiſhed, it never becomes ſo ſmall as u. Therefore u is a limit of diminution as well as of augmentation.

63 Relation between the time of deſcent and ſpace deſcribed, &c.

We muſt now aſcertain the relation between the time of the deſcent and the ſpace deſcribed, or the velocity acquired. For this purpoſe we may uſe the other fundamental propoſition of varied motions $ft = v$, which, in the preſent caſe, becomes $\frac{g\sqrt{u^2 - v^2}}{u^2} \dot{t} = \dot{v}$; therefore $\dot{t} =$

u^2

$\frac{u^2}{g}\times\frac{\dot{v}}{u^2-v^2}$, $=\frac{u}{g}\times\frac{u\dot{v}}{u^2-v^2}$, and $t=\frac{u}{g}\times f\frac{u\dot{v}}{u^2-v^2}$.

Now (art. FLUXIONS) $f\frac{u\dot{v}}{u^2-v^2}=\mathrm{L}\sqrt{\frac{u+v}{u-v}}$. Therefore $t=\frac{u}{g}\times\mathrm{L}\sqrt{\frac{u+v}{u-v}}=\frac{u}{\mathrm{M}g}\times\lambda\sqrt{\frac{u+v}{u-v}}$. This fluent needs no conſtant quantity to complete it, or rather $\mathrm{C}=o$; for t muſt be $=o$ when $v=o$. This will evidently be the caſe: for then $\mathrm{L}\sqrt{\frac{u+v}{u-v}}$ is $\mathrm{L}\sqrt{\frac{u}{u}}=\mathrm{L}\,1,=0$.

But how does this quantity $\frac{u}{\mathrm{M}g}\times\lambda\sqrt{\frac{u+v}{u-v}}$ ſignify a time? Obſerve, that in whatever numbers, or by whatever units of ſpace and time, u and g are expreſſed, $\frac{u}{g}$ expreſſes the number of units of time in which the velocity u is communicated or extinguiſhed by gravity; and $\mathrm{L}\sqrt{\frac{u+v}{u-v}}$, or $\frac{\lambda}{\mathrm{M}}\sqrt{\frac{u+v}{u-v}}$, is always an abſtract number, multiplying this time.

We may illuſtrate this rule by the ſame example. In what time will the body acquire the velocity 323,62? Here $u+v=1012{,}96$, $u-v=365{,}72$; therefore $\lambda\sqrt{\frac{u+v}{u-v}}=0{,}22122$, and $\frac{u}{g}$ (in feet and ſeconds) is $21'',542$. Now, for greater perſpicuity, convert the equation $t=\frac{u}{\mathrm{M}g}\times\lambda\sqrt{\frac{u+v}{u-v}}$ into a proportion: thus $\mathrm{M}:\lambda\sqrt{\frac{u+v}{u-v}}=\frac{u}{g}:t$, and we have $0{,}43429:0{,}22122=21'',542:10'',973$, the time required.

This is by far the moſt diſtinct way of conceiving the ſubject; and we ſhould always keep in mind that the numbers or ſymbols which we call logarithms are really parts of the line MI in the figure of the logiſtic curve, and that the motion of a point in this line is preciſely ſimilar to that of the body. The Marquis Poleni, in a diſſertation publiſhed at Padua in 1725, has with great ingenuity conſtructed logarithmics ſuited to all the caſes which can occur. Herman, in his *Phoronomia*, has borrowed much of Poleni's methods, but has obſcured them by an affectation of language geometrically preciſe, but involving the very obſcure notion of abſtract ratios.

It is eaſy to ſee that $\sqrt{\frac{u+v}{u-v}}$ is the cotangent of the $\frac{1}{2}$ complement of an arch, whoſe radius is 1, and whoſe ſine is $\frac{v}{u}$: For let KC (fig. 6.) be $=u$, and BE $=v$; then KD $=u+v$, and DA $=u-v$. Join KB and BA, and draw CG parallel to KB. Now GA is the tangent of $\frac{1}{2}$ BA, $=\frac{1}{2}$ complement of HB. Then, by ſimilarity of triangles, $\mathrm{GA}:\mathrm{AC}=\mathrm{AB}:\mathrm{BK}$, $=\sqrt{\mathrm{AD}}:\sqrt{\mathrm{DK}}=\sqrt{u-v}:\sqrt{u+v}$ and $\frac{\mathrm{AC}}{\mathrm{GA}}(=\text{cotan. }\frac{1}{2}\mathrm{BA})=\sqrt{\frac{u+v}{u-v}}$; therefore look for $\frac{v}{u}$ among the natural ſines, or for log. $\frac{v}{u}$ among the logarithmic ſines, and take the logarithmic cotangent of the half complement of the correſponding arch. This, conſidered as a common number, will be the ſecond term of our proportion. This is a ſhorter proceſs than the former.

Plate CCCCXVII.

By reverſing this proportion we get the velocity correſponding to a given time.

64 Fall of a body in air compared with that of one in vacuo.

To compare this deſcent of 1848 feet in the air with the fall of the body *in vacuo* during the ſame time, ſay $\overline{21'',542}^2:\overline{10'',973}^2=1848:1926{,}6$, which makes a difference of 79 feet.

Cor. 1. The time in which the body acquires the velocity u by falling through the air, is to the time of acquiring the ſame velocity by falling *in vacuo*, as u $\mathrm{L}\sqrt{\frac{u+v}{u-v}}$ to v: for it would acquire this velocity *in vacuo* during the time $\frac{v}{g}$, and it acquires it in the air in the time $\frac{u}{g}\mathrm{L}\sqrt{\frac{u+v}{u-v}}$.

2. The velocity which the body acquires by falling through the air in the time $\frac{u}{g}\mathrm{L}\sqrt{\frac{u+v}{u-v}}$, is to the velocity which it would acquire *in vacuo* during the ſame time, as v to $u\,\mathrm{L}\sqrt{\frac{u+v}{u-v}}$: For the velocity which it would acquire *in vacuo* during the time $\frac{u}{g}$ $\mathrm{L}\sqrt{\frac{u+v}{u-v}}$ muſt be $u\,\mathrm{L}\sqrt{\frac{u+v}{u-v}}$ (becauſe in any time $\frac{w}{g}$ the velocity w is acquired).

65 Time of the aſcent of a body projected perpendicularly.

In the next place, let a body, whoſe terminal velocity is u, be projected perpendicularly upwards, with any velocity V. It is required to determine the height to which it aſcends, ſo as to have any remaining velocity v, and the time of its aſcent; as alſo the height and time in which its whole motion will be extinguiſhed.

We have now $\frac{g(u^2+v^2)}{u^2}$ for the expreſſion of f; for both gravity and reſiſtance act now in the ſame direction, and retard the motion of the aſcending body: therefore $\frac{g(u^2+v^2)}{u^2}\dot{s}=-v\dot{v}$, and $\dot{s}=-\frac{u^2}{g}\times\frac{v\dot{v}}{u^2+v^2}$, and $s=-\frac{u^2}{g}\times f\frac{v\dot{v}}{u^2+v^2}+\mathrm{C},=-\frac{u^2}{g}\times\mathrm{L}\sqrt{u^2+v^2}+\mathrm{C}$ (ſee art. FLUXIONS). This muſt be $=o$ at the beginning of the motion, that is, when $v=\mathrm{V}$, that is, $-\frac{u^2}{g}\times\mathrm{L}\sqrt{u^2+\mathrm{V}^2}+\mathrm{C}=o$, or $\mathrm{C}=\frac{u^2}{g}\times\mathrm{L}\sqrt{u^2+\mathrm{V}^2}$, and the complete fluent will be $s=\frac{u^2}{g}\times(\mathrm{L}\sqrt{u^2+\mathrm{V}^2}-\mathrm{L}\sqrt{u^2+v^2})=\frac{u^2}{g}\times\mathrm{L}\sqrt{\frac{u^2+\mathrm{V}^2}{u^2+v}},=\frac{u^2}{\mathrm{M}g}\times\lambda\sqrt{\frac{u^2+\mathrm{V}^2}{u^2+v^2}}$

Let b be the greateſt height to which the body will riſe. Then $s=b$ when $v=o$; and $b=\frac{u^2}{g}\times\mathrm{L}\sqrt{\frac{u^2+\mathrm{V}^2}{u^2}},=\frac{u^2}{\mathrm{M}g}\times\lambda\sqrt{\frac{u^2+\mathrm{V}^2}{u^2}}$. We have $\lambda\sqrt{\frac{u^2+\mathrm{V}^2}{u^2+v^2}}=s\frac{mg}{u^2}$; therefore $\lambda\left(\frac{u^2+\mathrm{V}^2}{u^2+v^2}\right)=\frac{2\mathrm{M}gs}{u^2}$. Therefore

Therefore let n be the number whose common logarithm is $\frac{2Mgs}{u^2}$; we shall have $n = \frac{u^2+V^2}{u^2+v^2}$, and $v^2 = \frac{u^2+V^2}{n} - u^2$; and thus we obtain the relation of s and v, as in the case of descents: but we obtain it still easier by observing that $\sqrt{u^2+V^2}$ is the secant of an arch whose radius is u, and whose tangent is V, and that $\sqrt{u^2+v^2}$ is the secant of another arch of the same circle, whose tangent is v.

Let the same ball be projected upwards with the velocity 411,05 feet per second. Required the whole height to which it will rise?

Here $\frac{V}{u}$ will be found the tangent of $30.48\frac{1}{2}$, the logarithmic secant of which is 0,06606. This, multiplied by $\frac{u^2}{Mg}$, gives 2259 feet for the height. It would have risen 2640 feet in a void.

66 Velocity of projection compared with that with which it reaches the ground.

Suppose this body to fall down again. We can compare the velocity of projection with the velocity with which it again reaches the ground. The ascent and descent are equal: therefore $\sqrt{\frac{u^2+V^2}{u^2}}$, which multiplies the constant factor in the ascent, is equal to $\sqrt{\frac{u^2}{u^2-v^2}}$, the multiplier in the descent. The first is the secant of an arch whose tangent is V; the other is the secant of an arch whose sine is v. These secants are equal, or the arches are the same; therefore the velocity of projection is to the final returning velocity as the tangent to the sine, or as the radius to the cosine of the arch. Thus suppose the body projected with the terminal velocity, or $V = u$; then $v = \frac{u}{\sqrt{2}}$. If $V =$ 689, $v = 487$.

We must in the last place ascertain the relation of the space and the time.

Here $\frac{g(u^2+v^2)}{u^2}\dot{t} = -\dot{v}$, and $\dot{t} = -\frac{u^2}{g} \times \frac{\dot{v}}{u^2+v^2}$, $= -\frac{u}{g} \times \frac{u\dot{v}}{u^2+v^2}$; and $t = \frac{-u}{g} \times f\frac{u\dot{v}}{u^2+v^2} + C$. Now (art. Fluxions) $f\frac{u\dot{v}}{u^2+v^2}$ is an arch whose tangent $= \frac{v}{u}$ and radius 1; therefore $t = -\frac{u}{g} \times$ arc. tan. $\frac{v}{u} + C$. This must be $= o$ when $v = V$, or $C = \frac{u}{g} \times$ arc. tan. $\frac{V}{u} = o$, and $C = \frac{u}{g} \times$ arc. tan. $\frac{V}{u}$, and the complete fluent is $t = \frac{u}{g} \times \left(\text{arc. tan.}\frac{V}{u} - \text{arc. tan.}\frac{v}{u}\right)$. The quantities within the brackets express a portion of the arch of a circle whose radius is unity; and are therefore abstract numbers, multiplying $\frac{u}{g}$, which we have shown to be the number of units of time in which a heavy body falls *in vacuo* from the height a, or in which it acquires the velocity u.

67 Time of ascent limited.

We learn from this expression of the time, that however great the velocity of projection, and the height to which this body will rise, may be the time of its ascent is limited. It never can exceed the time of falling from the height a *in vacuo* in a greater proportion than that of a quadrantal arch to the radius, nearly the proportion of 8 to 5. A 24 pound iron ball cannot continue rising above 14 seconds, even if the resistance to quick motions did not increase faster than the square of the velocity. It probably will attain its greatest height in less than 12 seconds, let its velocity be ever so great.

In the preceding example of the whole ascent, $v = o$, and the time $t = \frac{u}{g} \times$ arc. tan. $\frac{V}{u}$, or $\frac{u}{g}$ arc. $30°.48'$. Now $30°.48' = 1848'$, and the radius 1 contains 3438; therefore the arch $= \frac{1848}{3438}$, $= 0,5376$; and $\frac{u}{g} = 21'',54$. Therefore $t = 21'',54 \times 0,5376, = 11'',58$, or nearly $11\frac{1}{2}$ seconds. The body would have risen to the same height in a void in $10\frac{3}{4}$ seconds.

68 This time compared in bodies projected in air and in vacuo.

Cor. 1. The time in which a body, projected in the air with any velocity V, will attain its greatest height, is to that in which it would attain its greatest height *in vacuo*, as the arch whose tangent expresses the velocity is to the tangent; for the time of the ascent in the air is $\frac{u}{g} \times$ arch; the time of the ascent *in vacuo* is $\frac{V}{g}$. Now $\frac{V}{u}$ is $=$ tan. and $V = u \times$ tan. and $\frac{V}{g} = \frac{u}{g} \times$ tan.

It is evident, by inspecting fig. 6. that the arch AI is to the tangent AG as the sector ICA to the triangle GCA; therefore the time of attaining the greatest height in the air is to that of attaining the greatest height *in vacuo* (the velocities of projection being the same), as the circular sector to the corresponding triangle. Plate ccccxvii.

If therefore a body be projected upwards with the terminal velocity, the time of its ascent will be to the time of acquiring this velocity *in vacuo* as the area of a circle to the area of the circumscribed square.

2. The height H to which a body will rise in a void, is to the height h to which it would rise through the air when projected with the same velocity V as $M \cdot V^2$ to $u^2 \times \lambda\frac{u^2+V^2}{u^2}$: for the height to which it will rise *in vacuo* is $\frac{V^2}{2g}$, and the height to which it rises in the air is $\frac{u^2}{Mg}\lambda\sqrt{\frac{u^2+V^2}{u^2}}$; therefore $H : h = \frac{V^2}{2g} : \frac{u^2}{Mg}\lambda\sqrt{\frac{u^2+V^2}{u^2}}, = V^2 : \frac{u^2}{M} \times 2\lambda\sqrt{\frac{u^2+V^2}{u^2}}, = V^2 : \frac{u^2}{M} \times \lambda\frac{u^2+V^2}{u^2}, = M \cdot V^2 : u^2 \times \lambda\frac{u^2+V^2}{u^2}$.

Therefore if the body be projected with its terminal velocity, so that $V = u$, the height to which it will rise in the air is $\frac{30103}{43429}$ of the height to which it will rise *in vacuo*, or $\frac{5}{7}$ in round numbers.

We have been thus particular in treating of the perpendicular ascents and descents of heavy bodies through the air, in order that the reader may conceive distinctly

the quantities which he is thus combining in his algebraic operations, and may ſee their connection in nature with each other. We ſhall alſo find that, in the preſent ſtate of our mathematical knowledge, this ſimple ſtate of the caſe contains almoſt all that we can determine with any confidence. On this account it were to be wiſhed that the profeſſional gentlemen would make many experiments on theſe motions. There is no way that promiſes ſo much for aſſiſting us in forming accurate notions of the air's reſiſtance. Mr Robins's method with the pendulum is impracticable with great ſhot; and the experiments which have been generally reſorted to for this purpoſe, viz. the ranges of ſhot and ſhells on a horizontal plane, are ſo complicated in themſelves, that the utmoſt mathematical ſkill is neceſſary for making any inferences from them; and they are ſubject to ſuch irregularities, that they may be brought to ſupport almoſt any theory whatever on this ſubject. But the perpendicular flights are affected by nothing but the initial velocity and the reſiſtance of the air; and a conſiderable deviation from their intended direction does not cauſe any ſenſible error in the conſequences which we may draw from them for our purpoſe.

69 Neceſſity of further experiments.

70 Of oblique projection.

But we muſt now proceed to the general problem, to determine the motion of a body projected in any direction, and with any velocity. Our readers will believe beforehand that this muſt be a difficult ſubject, when they ſee the ſimpleſt caſes of rectilineal motion abundantly abſtruſe: it is indeed ſo difficult, that Sir Iſaac Newton has not given a ſolution of it, and has thought himſelf well employed in making ſeveral approximations, in which the fertility of his genius appears in great luſtre. In the tenth and ſubſequent propoſitions of the ſecond book of the *Principia*, he ſhows what ſtate of denſity in the air will comport with the motion of a body in any curve whatever: and then, by applying this diſcovery to ſeveral curves which have ſome ſimilarity to the path of a projectile, he finds one which is not very different from what we may ſuppoſe to obtain in our atmoſphere. But even this approximation was involved in ſuch intricate calculations, that it ſeemed impoſſible to make any uſe of it. In the ſecond edition of the *Principia*, publiſhed in 1713, Newton corrects ſome miſtakes which he had committed in the firſt, and carries his approximations much farther, but ſtill does not attempt a direct inveſtigation of the path which a body will deſcribe in our atmoſphere. This is ſomewhat ſurpriſing. In prop. 14. &c. he ſhows how a body, actuated by a centripetal force, in a medium of a denſity varying according to certain laws, will deſcribe an eccentric ſpiral, of which he aſſigns the properties, and the law of deſcription. Had he ſuppoſed the denſity conſtant, and the difference between the greateſt and leaſt diſtances from the centre of centripetal force exceedingly ſmall in compariſon with the diſtances themſelves, his ſpiral would have coincided with the path of a projectile in the air of uniform denſity, and the ſteps of his inveſtigation would have led him immediately to the complete ſolution of the problem. For this is the real ſtate of the caſe. A heavy body is not acted on by equal and parallel gravity, but by a gravity inverſely proportional to the ſquare of the diſtance from the centre of the earth, and in lines tending to that centre nearly; and it was with the view of ſimplifying the

71 This problem not ſolved by Newton.

inveſtigation, that mathematicians have adopted the other hypotheſis.

72 Diſputes among Britiſh and foreign mathematicians.

Soon after the publication of this ſecond edition of the *Principia*, the diſpute about the invention of the fluxionary calculus became very violent, and the great promoters of that calculus upon the continent were in the habit of propoſing difficult problems to exerciſe the talents of the mathematician. Challenges of this kind frequently paſſed between the Britiſh and foreigners. Dr Keill of Oxford had keenly eſpouſed the claim of Sir Iſaac Newton to this invention, and had engaged in a very acrimonious altercation with the celebrated John Bernoulli of Baſle. Bernoulli had publiſhed in the *Acta Eruditorum Lipſiæ* an inveſtigation of the law of forces, by which a body moving in a reſiſting medium might deſcribe any propoſed curve, reducing the whole to the ſimpleſt geometry. This is perhaps the moſt elegant ſpecimen which he has given of his great talents. Dr Keill propoſed to him the particular problem of the trajectory and motion of a body moving through the air, as one of the moſt difficult. Bernoulli very ſoon ſolved the problem in a way much more general than it had been propoſed, viz. without any limitation either of the law of reſiſtance, the law of the centripetal force, or the law of denſity, provided only that they were regular, and capable of being expreſſed algebraically. Dr Brooke Taylor, the celebrated author of the Method of Increments, ſolved it at the ſame time, in the limited form in which it was propoſed. Other authors ſince that time have given other ſolutions. But they are all (as indeed they muſt be) the ſame in ſubſtance with Bernoulli's. Indeed they are all (Bernoulli's not excepted) the ſame with Newton's firſt approximations, modified by the ſteps introduced into the inveſtigation of the ſpiral motions mentioned above; and we ſtill think it moſt ſtrange that Sir Iſaac did not perceive that the *variation of curvature*, which he introduced in that inveſtigation, made the whole difference between his approximations and the complete ſolution. This we ſhall point out as we go along. And we now proceed to the problem itſelf, of which we ſhall give Bernoulli's ſolution, reſtricted to the caſe of uniform denſity and a reſiſtance proportional to the ſquare of the velocity. This ſolution is more ſimple and perſpicuous than any that has ſince appeared.

73 Bernoulli's ſolution.

Problem. To determine the trajectory, and all the circumſtances of the motion, of a body projected thro' the air from A (fig. 7.) in the direction AB, and reſiſted in the duplicate ratio of the velocity. Plate cccexvii.

Let the arch AM be put $=z$, the time of deſcribing it t, the abſciſſa AP$=x$, the ordinate PM $=y$. Let the velocity in the point M$=v$, and let MN, $=\dot{z}$, be deſcribed in the moment t; let r be the reſiſtance of the air, g the force of gravity, meaſured by the velocity which it will generate in a ſecond; and let a be the height through which a heavy body muſt fall *in vacuo* to acquire the velocity which would render the reſiſtance of the air equal to its gravity: ſo that we have $r=\frac{v^2}{2a}$; becauſe, for any velocity u, and producing height b, we have $g=\frac{u^2}{2b}$

Let Mm touch the curve in M; draw the ordinate pNm,

pNm, and draw Mo, Nn perpendicular to Np and Mm. Then we have MN$=\dot{z}$, and M$o=\dot{x}$, alſo $m\,o$ is ultimately $=\dot{y}$ and Mm is ultimately = MN or $\dot{z}$. Laſtly, let us ſuppoſe $\dot{x}$ to be a conſtant quantity, the elementary ordinates being ſuppoſed equidiſtant.

74 Action of gravity in a given time.

The action of gravity during the time $\dot{t}$ may be meaſured by mN, which is half the ſpace which it would cauſe the body to deſcribe uniformly in the time $\dot{t}$ with the velocity which it generates in that time. Let this be reſolved into nN, by which it deflects the body into a curvilineal path, and $m\,n$, by which it retards the aſcent and accelerates the deſcent of the body along the tangent. The reſiſtance of the air acts ſolely in retarding the motion, both in aſcending and deſcending, and has no deflective tendency. The whole action of gravity then is to its accelerating or retarding tendency as mN to $m\,n$, or (by ſimilarity of triangles) as mM to $m\,o$. Or $\dot{z}:\dot{y}=g:\frac{g\dot{y}}{\dot{z}}$, and the whole retardation in the aſcent will be $r+\frac{g\dot{y}}{\dot{z}}$. The ſame fluxionary ſymbol will expreſs the retardation during the deſcent, becauſe in the deſcent the ordinates decreaſe, and $\dot{y}$ is a negative quantity.

The diminution of velocity is $-\dot{v}$. This is proportional to the retarding force and to the time of its action jointly, and therefore $-\dot{v}=r+\frac{g\dot{y}}{\dot{z}}\times\dot{t}$; but the time $\dot{t}$ is as the ſpace $\dot{z}$ divided by the velocity v; therefore $-\dot{v}=r+\frac{g\dot{y}}{\dot{z}}\times\frac{\dot{z}}{v}$, $=-\frac{r\dot{z}+g\dot{y}}{v}$, and $-v\dot{v}=-r\dot{z}-g\dot{y}$, $=\frac{v^2\dot{z}}{2a}-g\dot{y}$. Becauſe mN is the deflection by gravity, it is as the force g and the ſquare of the time t jointly (the momentary action being held as uniform). We have therefore mN, or $-\ddot{y}=g\dot{t}^2$. (Obſerve that mN is in fact only the half of $-\ddot{y}$; but g being twice he fall of a heavy body in a ſecond, we have $-\ddot{y}$ ſtrictly equal to $g\dot{t}^2$). But $\dot{t}^2=\frac{\dot{z}^2}{v^2}$; therefore $-\ddot{y}=\frac{g\dot{z}^2}{v^2}$, and $v^2=\frac{g\dot{z}^2}{-\ddot{y}}$, and $-v^2\ddot{y}=g\dot{z}^2$. The fluxion of this equation is $-v^2\dddot{y}-2v\ddot{y}\dot{v}=2g\dot{z}\ddot{z}$; but, becauſe $\dot{z}:\dot{y}=m$M$:m\,o$, $=m$N$:m\,n$, $=\ddot{y}:\ddot{z}$, we have $\dot{z}\ddot{z}=\dot{y}\ddot{y}$. Therefore $2g\dot{y}\ddot{y}=2g\dot{z}\ddot{z}$, $=-v^2\dddot{y}-2v\ddot{y}\dot{v}$, and $-2v\dot{v}\ddot{y}=v^2\dddot{y}-2g\dot{y}\ddot{y}$, and $-v\dot{v}=\frac{v^2\dddot{y}}{2\ddot{y}}-g\dot{y}$. But we have already $-v\dot{v}=\frac{v^2\dot{z}}{2a}-g\dot{y}$; therefore $\frac{v^2\dddot{y}}{\ddot{y}}=\frac{v^2\dot{z}}{a}$, and finally $\frac{\dddot{y}}{\ddot{y}}=\frac{\dot{z}}{a}$, or $a\dddot{y}=\dot{z}\ddot{y}$, for the fluxionary equation of the curve.

75 Relation between the length of the curve and its variation of curvature.

If we put this into the form of a proportion, we have $a:\dot{z}=\ddot{y}:\dddot{y}$. Now this evidently eſtabliſhes a relation between the length of the curve and its variation of curvature; and between the curve itſelf and its evoluta, which are the very circumſtances introduced by Newton into his inveſtigation of the ſpiral motions. And the equation $\frac{\dot{z}}{a}=\frac{\dddot{y}}{\ddot{y}}$ is evidently an equation connected with the logarithmic curve and the logarithmic ſpiral. But we muſt endeavour to reduce it to a lower order of fluxions, before we can eſtabliſh a relation between z, x, and y.

Let p expreſs the ratio of $\dot{y}$ to $\dot{x}$, that is, let p be $=\frac{\dot{y}}{\dot{x}}$, or $p\dot{x}=\dot{y}$. It is evident that this expreſſes the inclination of the tangent at M to the horizon, and that p is the tangent of this inclination, radius being unity. Or it may be conſidered merely as a number, multiplying $\dot{x}$, ſo as to make it $=\dot{y}$. We now have $\dot{y}^2=p^2\dot{x}^2$, and ſince $\dot{z}^2=\dot{x}^2+\dot{y}^2$, we have $\dot{z}^2=\dot{x}^2+p^2\dot{x}^2$, $=\overline{1+p^2}\times\dot{x}^2$ and $\dot{z}=\dot{x}\sqrt{1+p^2}$.

Moreover, becauſe we have ſuppoſed the abſciſſa x to increaſe uniformly, and therefore $\dot{x}$ to be conſtant, we have $\ddot{y}=\dot{x}\dot{p}$, and $\dddot{y}=\dot{x}\ddot{p}$. Now let q expreſs the ratio of $\dot{p}$ to $\dot{x}$, that is, make $\frac{\dot{p}}{\dot{x}}=q$, or $q\dot{x}=\dot{p}$. This gives us $\dot{x}\dot{q}=\ddot{p}$, and $\dot{x}^2\dot{q}=\dot{x}\ddot{p}$, $=\dddot{y}$.

By theſe ſubſtitutions our former equation $a\dddot{y}=\dot{z}\ddot{y}$ changes to $a\dot{x}^2\dot{q}=\dot{x}\sqrt{1+p^2}\,\dot{x}\dot{p}$, or $a\dot{q}=\dot{p}\sqrt{1+p^2}$, and, taking the fluent on both ſides, we have $aq=f\dot{p}\sqrt{1+p^2}+$C, C being the conſtant quantity required for completing the fluent according to the limiting conditions of the caſe. Now $\dot{x}=\frac{\dot{p}}{q}$, and $\frac{1}{q}=f,\frac{a}{\dot{p}\sqrt{1+p^2}}+$C. Therefore $\dot{x}=f,\frac{a\dot{p}}{p\sqrt{1+p^2}}+$C

Alſo, ſince $\dot{y}=p\dot{x}$, $=\frac{p\dot{p}}{q}$, we have $y=f,\frac{a\,p\,\dot{p}}{\dot{p}\sqrt{1+p^2}}+$C

Alſo $\dot{z}=\dot{x}\sqrt{1+p^2}=\frac{a\dot{p}\sqrt{1+p^2}}{f,\dot{p}\sqrt{1+p^2}+\text{C}}$

The values of $\dot{x}$, $\dot{y}$, $\dot{z}$, give us

$x=f,\frac{a\dot{p}}{f,\dot{p}\sqrt{1+p^2}+\text{C}}=a\,f\frac{\dot{p}}{f\dot{p}\sqrt{1+p^2}+\text{C}}$

$$y = f\frac{ap\dot{p}}{f,\dot{p}\sqrt{1+p^2}|+C}, = af\frac{p\dot{p}}{f,\dot{p}\sqrt{1+p^2}|+C}.$$

$$x = f,\frac{a\sqrt{1+p^2}|\dot{p}}{f,\dot{p}\sqrt{1+p^2}|+C}, = af\frac{\dot{p}\sqrt{1+p^2}}{f,\dot{p}\sqrt{1+p^2}|+C}.$$

The proceſs therefore of deſcribing the trajectory is, 1*ſt*. To find q in terms of p by the area of the curve whoſe abſciſſa is p and the ordinate is $\sqrt{1+p^2}$.

2*d*, We get x by the area of another curve whoſe abſciſſa is p, and the ordinate is $\frac{1}{q}$.

3*d*, We get y by the area of a third curve whoſe abſciſſa is p, and the ordinate is $\frac{p}{q}$

76 To compute the magnitude of the ordinate and abſciſſa.

The problem of the trajectory is therefore completely ſolved becauſe we have determined the ordinate, abſciſſa, and arch of the curve for any given poſition of its tangent It now only remains to compute the magnitudes of theſe ordinates and abſciſſæ, or to draw them by a geometrical conſtruction. But in this conſiſts the difficulty. The areas of theſe curves, which expreſs the lengths of x and y, can neither be computed nor exhibited geometrically, by any accurate method *yet* diſcovered, and we muſt content ourſelves with approximations. Theſe render the deſcription of the trajectory exceedingly difficult and tedious, ſo that little advantage has as yet been derived from the knowledge we have got of its properties. It will however greatly aſſiſt our conception of the ſubject to proceed ſome length in this conſtruction; for it muſt be acknowledged that very few diſtinct notions accompany a mere algebraic operation, eſpecially if in any degree complicated, which we confeſs is the caſe in the preſent queſtion.

Plate CCCCXVIII.

Let B *m* NR (fig. 8.) be an equilateral hyperbola, of which B is the vertex, BA the ſemitranſverſe axis, which we ſhall aſſume for the unity of length. Let AV be the ſemiconjugate axis = BA, = unity, and AS the aſſymptote, biſecting the right angle BAV. Let PN, *p n* be two ordinates to the conjugate axis, exceedingly near to each other. Join BP, AN, and draw B$^{\beta}$, N$^{\nu}$ perpendicular to the aſſymptote, and BC parallel to AP. It is well known that BP is equal to NP. Therefore $PN^2 = BA^2 + AP^2$. Now ſince BA = 1, if we make AP = p of our formulæ, PN is $\sqrt{1+p^2}$, and Pp is = $\dot{p}$, and the area $BAPNB = f,\dot{p}\sqrt{1+p^2}|$. That is to ſay, the number $f,\dot{p}\sqrt{1+p^2}$ (for it is a number) has the ſame proportion to unity of number that the area BAPNB has to BCVA, the unit of ſurface. This area conſiſts of two parts, the triangle APN, and the hyperbolic ſector ABN. APN = $\frac{1}{2}$ AP × PN, = $\frac{1}{2}p\sqrt{1+p^2}$, and the hyperbolic ſector ABN = BN$_{\nu\beta}$, which is equivalent to the hyperbolic logarithm of the number repreſented by A$_{\nu}$ when A$_{\beta}$ is unity. Therefore it is equal to $\frac{1}{2}$ the logarithm of $p+\sqrt{1+p^2}$. Hence we ſee by the bye that $f,\dot{p}\sqrt{1+p^2} = \frac{1}{2}p\sqrt{1+p^2} + \frac{1}{2}$ hyperbolic logarithm $p+\sqrt{1+p^2}$.

Now let AMD be another curve, ſuch that its ordinates V *m*, PD, &c. may be proportional to the areas AB *m* V, ABNP, and may have the ſame proportion to AB, the unity of length, which theſe areas have to ABCV, the unity of ſurface. Then VM : VC = V*m* BA : VCBA and PD : Pδ = PNBA : VCBA, &c. Theſe ordinates will now repreſent $f,\dot{p}\sqrt{1+p^2}$ with reference to a linear unit, as the areas to the hyperbola repreſented it in reference to a ſuperficial unit.

Again, in every ordinate make PD : Pδ = Pδ : PO, and thus we obtain a reciprocal to PD or to $f,\dot{p}\sqrt{1+p^2}$, or equivalent to $f,\frac{1}{\dot{p}\sqrt{1+p^2}}$. This will evidently be $\frac{\dot{x}}{ap}$, and PO *o p* will be $\frac{\dot{x}}{a}$, and the area contained between the lines AF, AW, and the curve GEOH, and cut off by the ordinate PO, will repreſent $\frac{x}{a}$.

Laſtly, make PO : PQ = AV : AP, = 1 : p; and then PQ *q p* will repreſent $\frac{\dot{y}}{a}$, and the area ALEQP will repreſent $\frac{y}{a}$.

But we muſt here obſerve, that the fluents expreſſed by theſe different areas require what is called the *correction* to accommodate them to the circumſtances of the caſe. It is not indifferent from what ordinate we begin to reckon the areas. This depends on the initial direction of the projectile, and that point of the abſciſſa AP muſt be taken for the commencement of all the areas which gives a value of p ſuited to the initial direction. Thus, if the projection has been made from A (fig. 7.) at an elevation of 45°, the ratio of the fluxions x and y is that of equality; and therefore the point E of fig. 8. where the two curves interſect and have a common ordinate, evidently correſponds to this condition. The ordinate EV paſſes through V, ſo that AV or p = AB, = 1, = tangent 45°, as the caſe requires. The values of x and of y correſponding to any other point of the trajectory, ſuch as that which has AP for the tangent of the angle which it makes with the horizon, are now to be had by computing the areas VEOP, VEQP.

Plate CCCCXVII. Plate CCCCXVIII.

Another curve might have been added, of which the ordinates would exhibit the fluxions of the arch of the trajectory $\dot{z} = \frac{a\dot{p}\sqrt{1+p^2}}{f,\dot{p}\sqrt{1+p^2}|+C}$ and of which the area would exhibit the arch itſelf. And this would have been very eaſy, for it is $\dot{z} = a\frac{\dot{p}\sqrt{1+p^2}}{f,\dot{p}\sqrt{1+p^2}|+C}$, which is evidently the fluxion of the hyperbolic logarithm of $f,\dot{p}\sqrt{1+p^2}|$. But it is needleſs, ſince $\dot{z} = \dot{x}\sqrt{1+p^2}$, and we have already got $\dot{x}$. It is only increaſing PO in the ratio of BA to BP.

77 Conſequences of knowing the form of the trajectory.

And thus we have brought the inveſtigation of this problem a conſiderable length, having aſcertained the *form* of the trajectory. This is ſurely done when the ratio of the arch, abſciſs, and ordinate, and the poſition of its tangent, is determined in every point. But it is ſtill very far from a ſolution, and much remains to be done before we can make any practical application of it. The only general conſequence that we can deduce from the premiſes

Fig. 1.

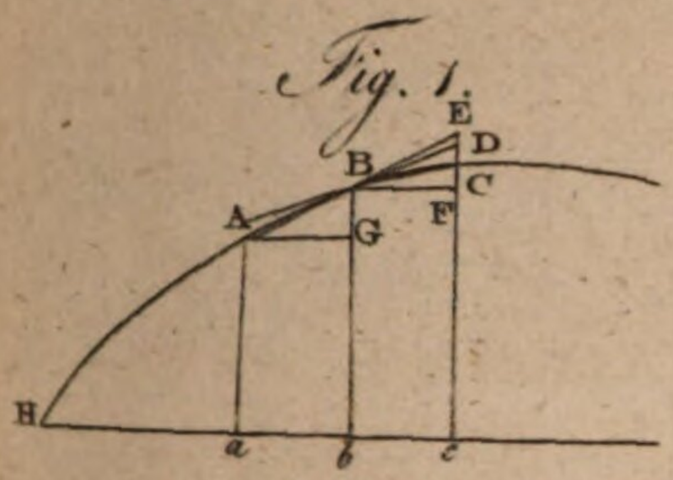


Fig. 2.

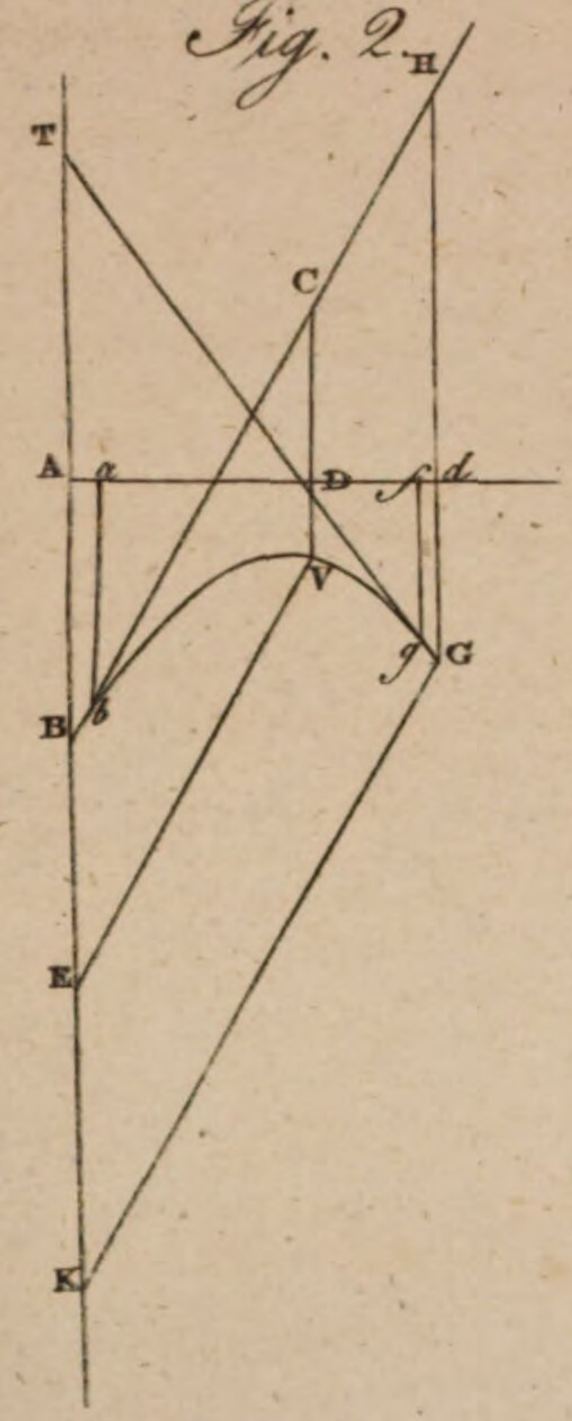


Fig. 3.

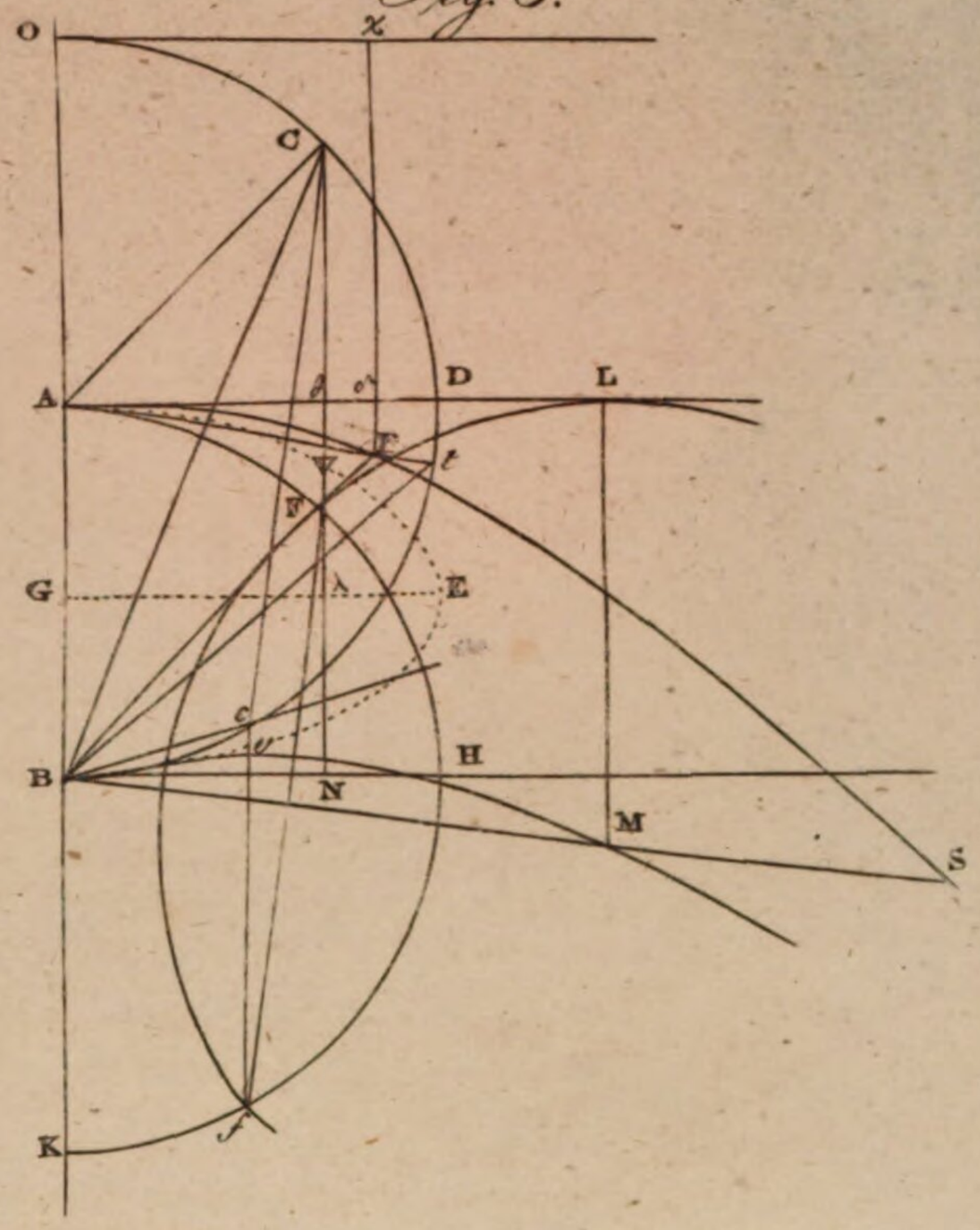


Fig. 4.

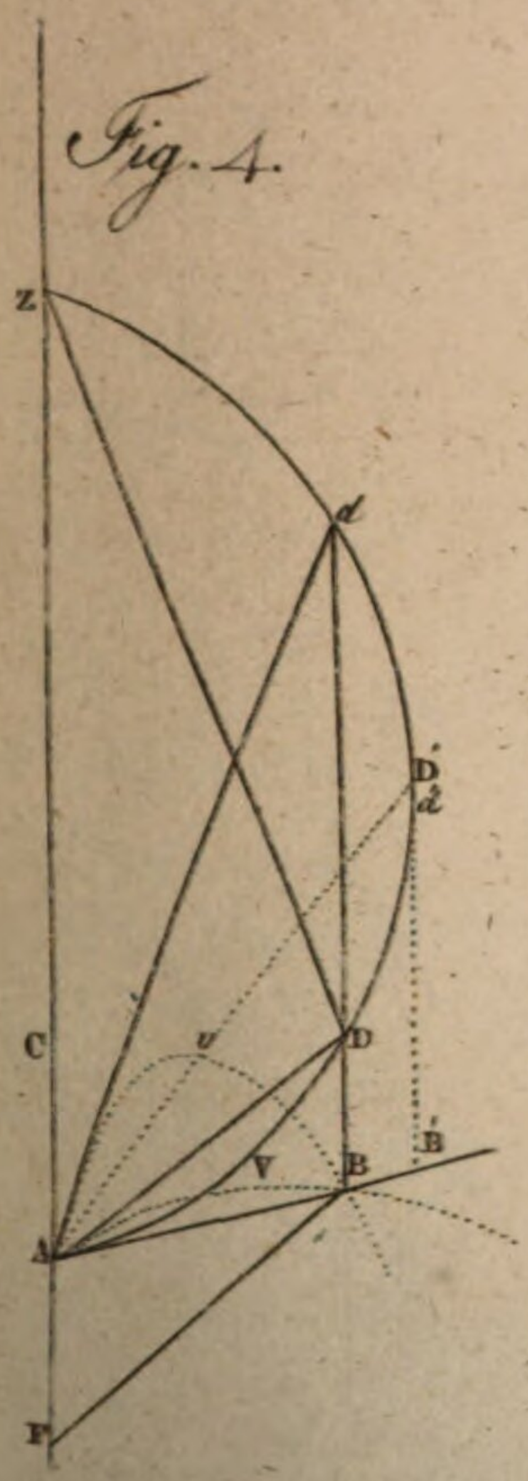


Fig. 5, called by mistake in the print 6 see 552 p.

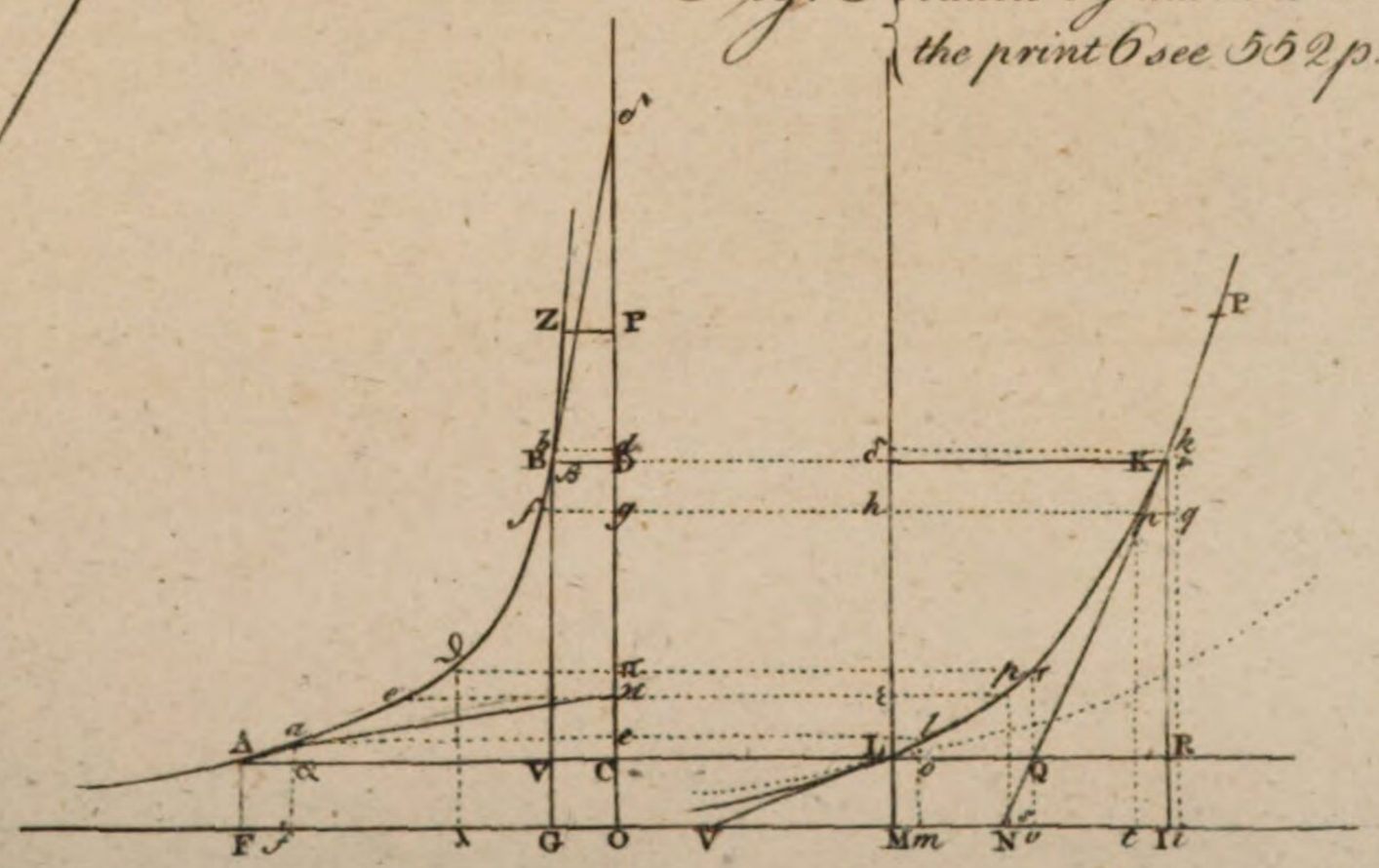


Fig. 6.

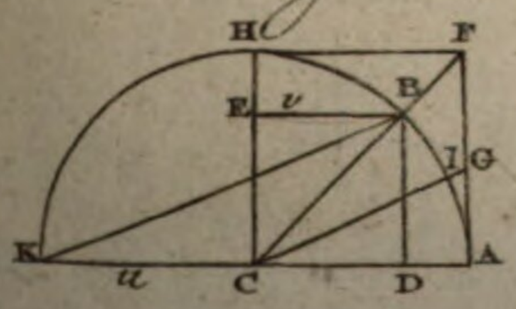
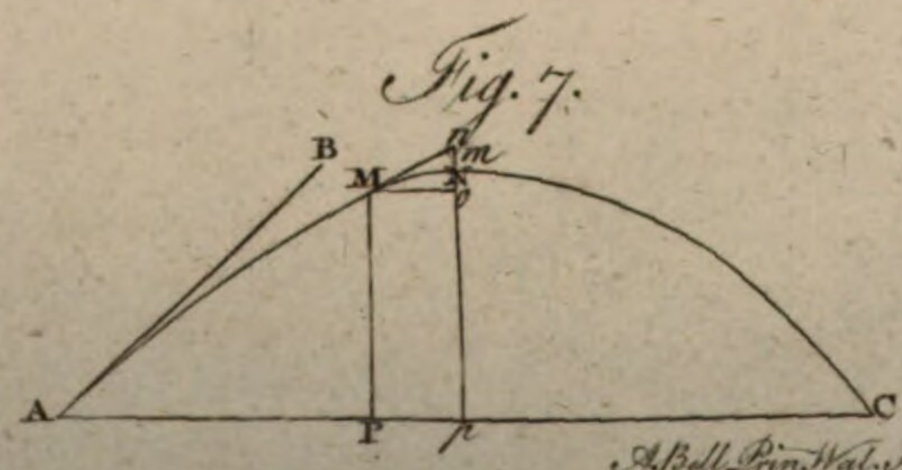


Fig. 7.



A Bell, Prin. Wal. Sculptor fecit.

PROJECTION of the SPHERE. Plate CCCCXIX.

Fig. 1.

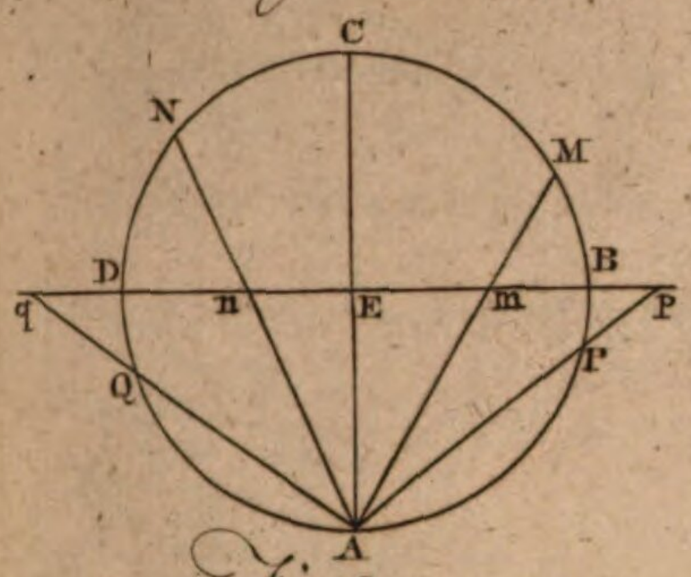
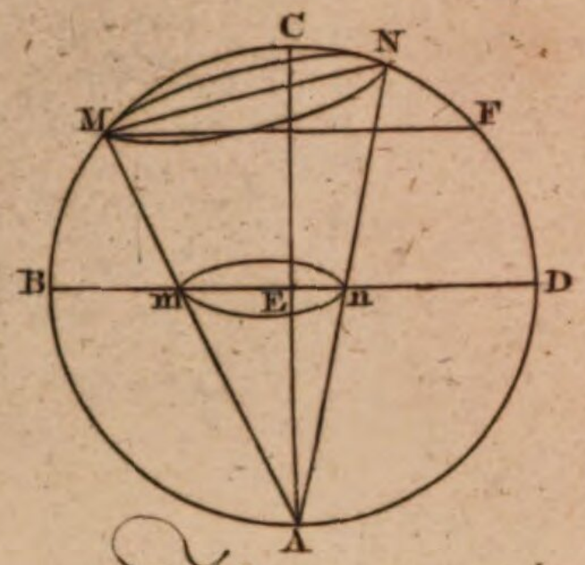


Fig. 2.



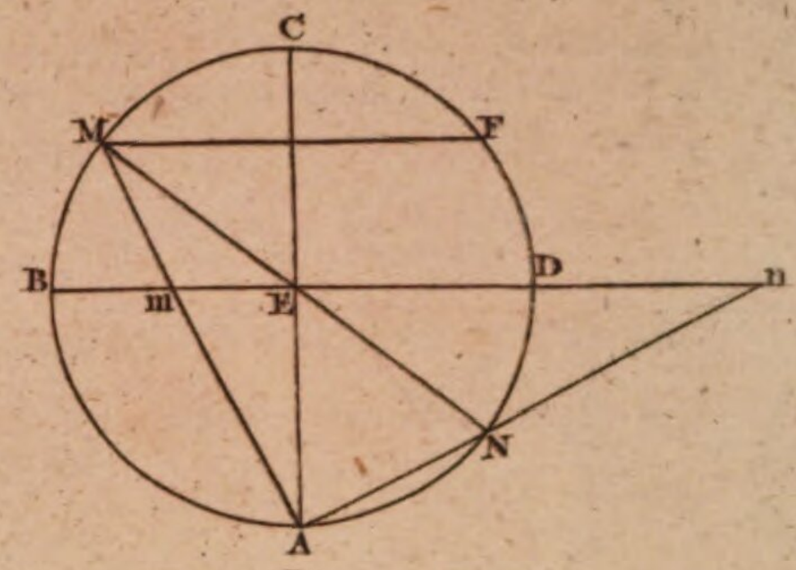
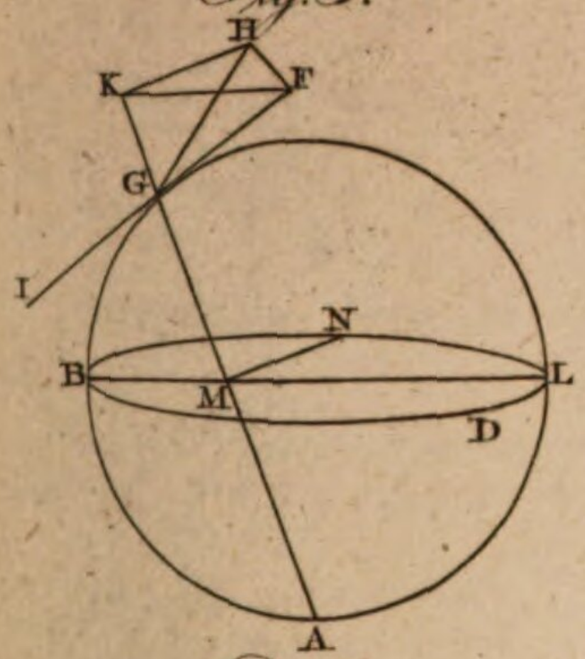
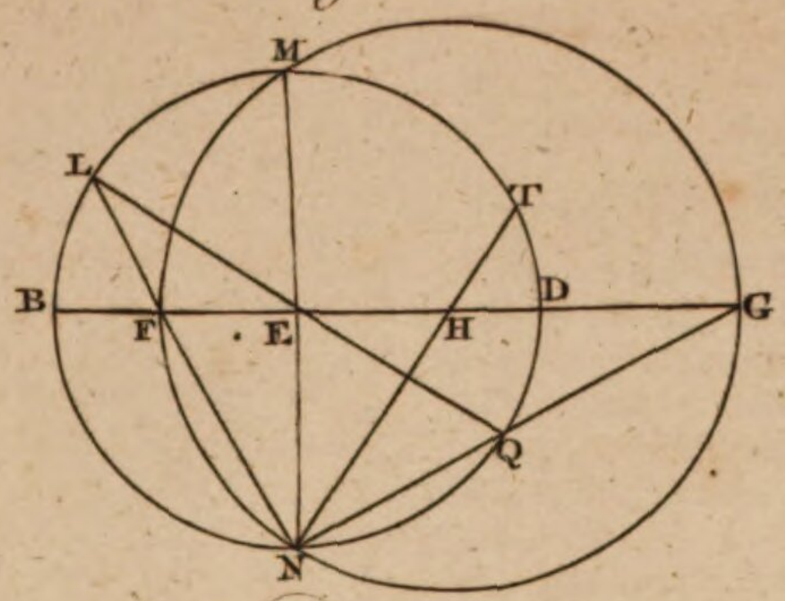


Fig. 3.

Fig. 4.

Fig. 5.





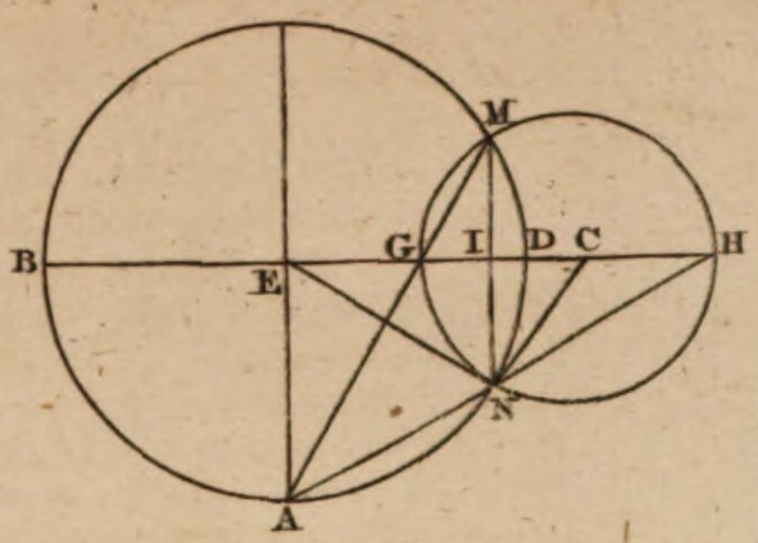
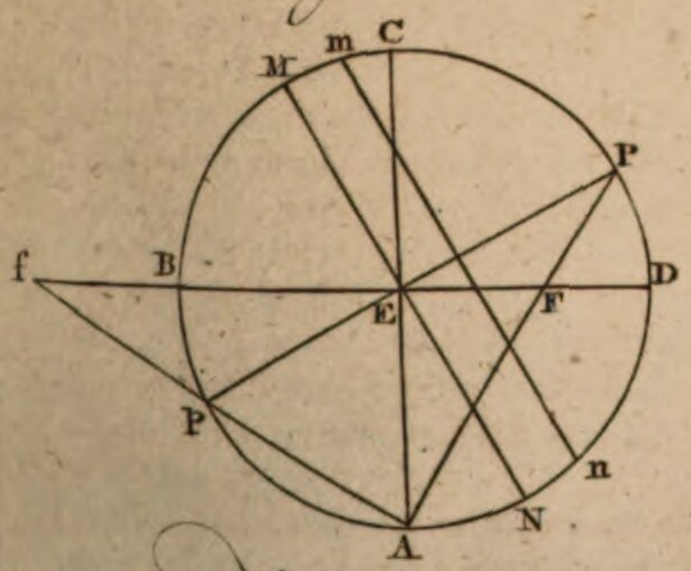
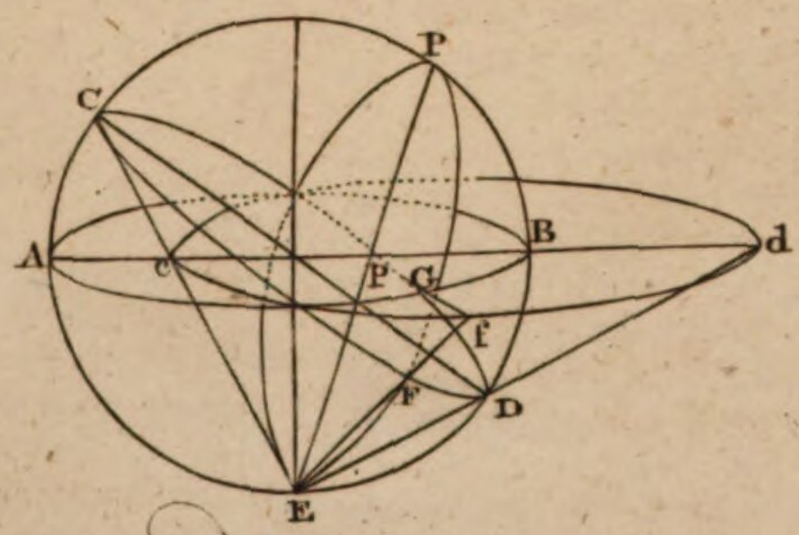


Fig. 6.

Fig. 7.

Fig. 8.





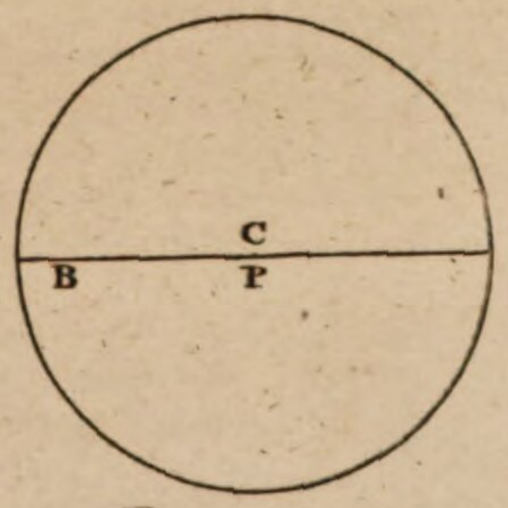
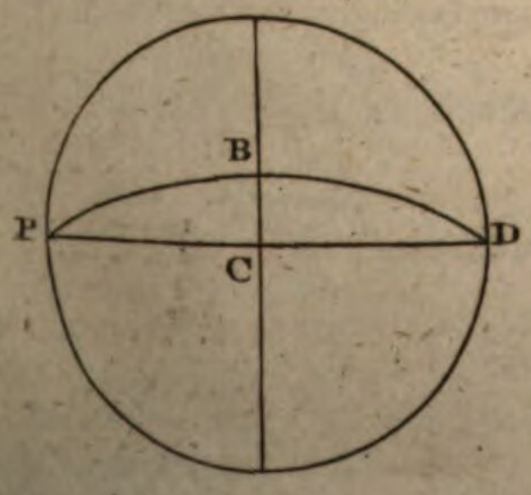
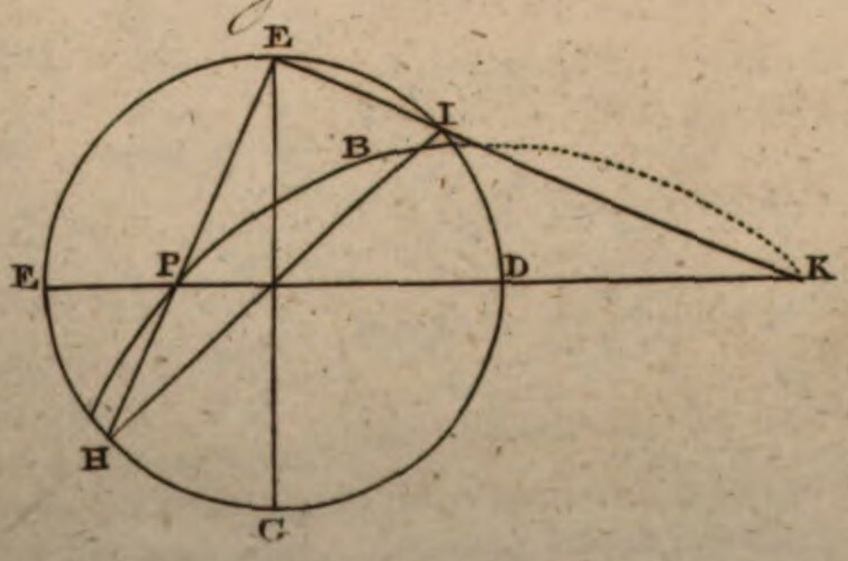


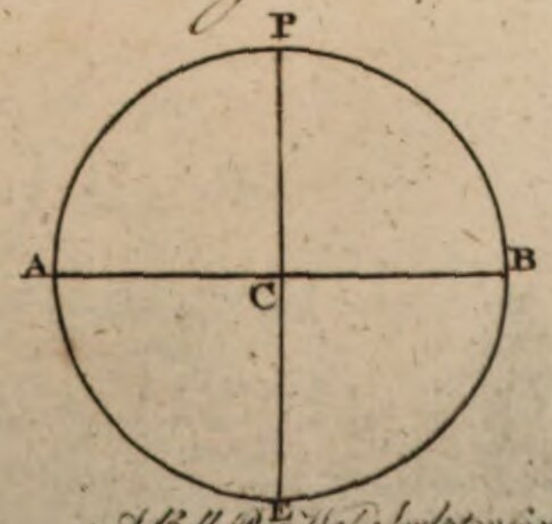
Fig. 9.

Fig. 10.

Fig. 11.







A.B.Bell Print.Val.Sculptor pinxt

Ies is, that in every caſe where the reſiſtance in any point bears the ſame proportion to the force of gravity, the trajectory will be ſimilar. Therefore two balls, of the ſame denſity, projected in the ſame direction, will deſcribe ſimilar trajectories if the velocities are in the ſubduplicate ratio of the diameters. This we ſhall find to be of conſiderable practical importance. But let us now proceed to determine the velocity in the different points of the trajectory, and the time of deſcribing its ſeveral portions.

78 To determine the velocity in different points.

Recollect, therefore, that $v^2 = \frac{-g\dot{z}^2}{\ddot{y}}$ and that $\dot{z}^2 = \dot{x}^2\overline{1+p^2}$ and $\ddot{y} = \dot{x}\dot{p}$. This gives $v^2 = \frac{-g\dot{x}\overline{1+p^2}}{\dot{p}}$.

But $\dot{p} = q\dot{x}$. Therefore $v^2 = \frac{-g\times\overline{1+p^2}}{q}$, $= \frac{-ag\overline{1+p^2}}{f,\dot{p}\sqrt{1+p^2}+C}$, and $v = \sqrt{\frac{-g\overline{1+p^2}}{q}}$, $= \frac{\sqrt{a}\sqrt{-g}\sqrt{1+p^2}}{\sqrt{f\dot{p}\sqrt{1+p^2}|+C}}$.

Alſo i was found $= \frac{\dot{z}}{v}$, $= \frac{\dot{x}\sqrt{1+p^2}}{v}$, $= \frac{\dot{p}\sqrt{1+p^2}}{qv}$. If we now ſubſtitute for v its value juſt found, we obtain $i = \frac{\dot{p}}{\sqrt{-gq}}$, and $t = f\frac{\dot{p}}{\sqrt{-gq}}$, $= f\frac{\dot{p}\sqrt{a}}{\sqrt{-gf\dot{p}\sqrt{1+p^2}|+C}}$, $= \frac{\sqrt{a}}{\sqrt{-g}}\times f\frac{\dot{p}}{\sqrt{f\dot{p}\sqrt{1+p^2}|+C}}$.

79 Difficulty of accommodating the formulæ to particular caſes.

The greateſt difficulty ſtill remains, viz. the accommodating theſe formulæ, which appear abundantly ſimple, to the particular caſes. It would appear at firſt ſight, that all trajectories are ſimilar; ſince the ratio of the fluxions of the ordinate and abſciſſa correſponding to any particular angle of inclination to the horizon ſeems the ſame in them all: but a due attention to what has been hitherto ſaid on the ſubject will ſhow us that we have as yet only been able to aſcertain the velocity in the point of the trajectory, which has a certain inclination to the horizon, indicated by the quantity p, and the time (reckoned from ſome aſſigned beginning) when the projectile is in that point.

To obtain abſolute meaſures of theſe quantities, the term of commencement muſt be fixed upon. This will be expreſſed by the conſtant quantity C, which is aſſumed for completing the fluent of $\dot{p}\sqrt{1+p^2}$, which is the baſis of the whole conſtruction. We there found $q = \frac{f,\dot{p}\sqrt{1+p^2}}{a}$. This fluent is in general $q = \frac{C+f,\dot{p}\sqrt{1+p^2}}{a}$, and the conſtant quantity C is to be accommodated to ſome circumſtances of the caſe. Different authors have ſelected different circumſtances. Euler,

80 Euler's method the ſimpleſt.

in his Commentary on Robins, and in a diſſertation in the Memoirs of the Academy of Berlin publiſhed in 1753, takes the vertex of the curve for the beginning of his abſciſſa and ordinate. This is the ſimpleſt method of any, for C muſt then be ſo choſen that the whole fluent may vaniſh when $p = o$, which is the caſe in the vertex of the curve, where the tangent is parallel to the horizon. We ſhall adopt this method.

Therefore, let AP (fig. 9.) $= x$, PM $= y$, AM $= z$. Put the quantity C which is introduced into the fluent equal to $\frac{n}{a}$. It is plain that n muſt be a number; for it muſt be homologous with $\dot{p}\sqrt{1+p^2}$, which is a number. For brevity's ſake let us expreſs the fluent of $\dot{p}\sqrt{1+p^2}$ by the ſingle letter P; and thus we ſhall have $x = a\times f\frac{\dot{p}}{n+P}$, $y = a\times f\frac{p\dot{p}}{n+P}$, $z = a\times f\frac{\dot{p}\sqrt{1+p^2}}{n+P}$. And $v^2 = \frac{-ag(1+p^2)}{n+P}$. Now the height h neceſſary for communicating any velocity v is $\frac{v^2}{2g} = \frac{-ag.(1+p^2)}{2g(n+P)}$, $= \frac{-\frac{1}{2}a(1+p^2)}{n+P}$. And laſtly, $t = \frac{\sqrt{a}}{\sqrt{g}}f\frac{\dot{p}}{\sqrt{n+P}}$.

Plate ccccxviii.

Theſe fluents, being all taken ſo as to vaniſh at the vertex, where the computation commences, and where p is $= o$ (the tangent being parallel to the horizon), we obtain in this caſe $b = \frac{\frac{1}{2}a}{n}$, $= \frac{a}{2n}$, and $n = \frac{a}{2b}$.

Hence we ſee that the circumſtance which modifies all the curves, diſtinguiſhing them from each other, is the velocity (or rather its ſquare) in the higheſt point of the curve. For b being determined for any body whoſe terminal velocity is u, n is alſo determined; and this is the modifying circumſtance. Conſidering it geometrically, it is the area which muſt be cut off from the area DMAP of fig. 8. in order to determine the ordinates of the other curves.

We muſt farther remark, that the values now given relate only to that part of the area where the body is deſcending from the vertex. This is evident; for, in order that y may increaſe as we recede from the vertex, its fluxion muſt be taken in the oppoſite ſenſe to what it was in our inveſtigation. *There* we ſuppoſed y to increaſe as the body aſcended, and then to diminiſh during the deſcent; and therefore the fluxion of y was firſt poſitive and then negative.

The ſame equations, however, will ſerve for the aſcending branch CNA of the curve, only changing the ſign of P; for if we conſider y as decreaſing during the aſcent, we muſt conſider q as expreſſing $\frac{-\dot{p}}{\dot{x}}$, and therefore P, or $f\dot{p}\sqrt{1+p^2}$, which is $= \frac{q}{a}$, muſt be taken negatively. Therefore, in the aſcending branch, we have AQ or x (increaſing as we recede from A)— $a\times f\frac{\dot{p}}{n-P}$, QN or $y = a\times f\frac{p\dot{p}}{n-P}$, AN or $z = a\times f\frac{\dot{p}\sqrt{1+p^2}}{n-P}$, $t = \frac{\sqrt{a}}{\sqrt{g}}\times f\frac{\dot{p}}{\sqrt{1-P}}$, and the height producing the velocity at N $= \frac{\frac{1}{2}a(1+p^2)}{n-P}$.

81 Remarkable property of the curve or trajectory.

Hence we learn by the bye, that in no part of the aſcending branch can the inclination of the tangent be ſuch

such that P shall be greater than n; and that if we suppose P equal to n in any point of the curve, the velocity in that point will be infinite. That is to say, there is a certain assignable elevation of the tangent which cannot be exceeded in a curve which has this velocity in the vertex. The best way for forming a conception of this circumstance in the nature of the curve, is to invert the motion, and suppose an accelerating force equal and opposite to the resistance, to act on the body in conjunction with gravity. It must describe the same curve, and this branch ANC must have an assymptote LO, which has this limiting position of the tangent. For, as the body descends in this curve, its velocity increases to infinity by the joint action of gravity and this *accelerating* force, and yet the tangent never approaches so near the perpendicular position as to make $P=n$. This remarkable property of the curve was known to Newton, as appears by his approximations, which all lead him to curves of a hyperbolic form, having one assymptote inclined to the horizon. Indeed it is pretty obvious: For the resistance increasing faster than the velocity, there is no velocity of projection so great but that the curve will come to deviate so from the tangent, that in a finite time it will become parallel to the horizon. Were the resistance proportional to the velocity, then an infinite velocity would produce a rectilineal motion, or rather a deflection from it less than any that can be assigned.

82 On what its form and magnitude depends.

We now see that the particular form and magnitude of this trajectory depends on two circumstances, a and n. a affects chiefly the magnitude. Another circumstance might indeed be taken in, viz. the diminution of the accelerating force of gravity by the statical effect of the air's gravity. But, as we have already observed, this is too trifling to be attended to in military projectiles.

$\frac{y}{x}$ was made equal to $\dot{p}$. Therefore the radius of curvature, determined by the ordinary methods, is $\frac{\dot{x}(1+p^2)(\sqrt{1+p^2})}{\dot{p}}$ *, and, because $\frac{\dot{x}}{\dot{p}}$ is $=\frac{a}{n+P}$ for the descending branch of the curve, the radius of curvature at M is $\frac{a\times 1+p^2\times\sqrt{1+p^2}}{n+P}$, and, in the ascending branch at N, it is $\frac{a\times 1+p^2\times\sqrt{1+p^2}}{n-P}$.

* *Simpson's Fluxions*, § 68, &c.

On both sides therefore, when the velocity is infinitely great, and P by this means supposed to equal or exceed n, the radius of curvature is also infinitely great. We also see that the two branches are unlike each other, and that when p is the same in both, that is, when the tangent is equally inclined to the horizon, the radius of curvature, the ordinate, the abscis, and the arch, are all greater in the ascending branch. This is pretty obvious. For as the resistance acts entirely in diminishing the velocity, and does not affect the deflection occasioned by gravity, it must allow gravity to incurvate the path so much the more (with the same inclination of its line of action) as the velocity is more diminished. The curvature, therefore, in those points which have the same inclination of the tangent, is greatest in the descending branch, and the motion is swiftest in the ascending branch. It is otherwise in a void, where both sides are alike. Here u becomes infinite, or there is no terminal velocity; and n also becomes infinite, being $=\frac{a}{2b}$.

It is therefore in the quantity P, or $\int \dot{p}\sqrt{1+p^2}$, that the difference between the trajectory in a void and in a resisting medium consists; it is this quantity which expresses the accumulated change of the ratio of the increments of the ordinate and abscis. In vacuo the second increment of the ordinate is constant when the first increment of the abscissa is so, and the whole increment of the ordinate is as $1+p$. And this difference is so much the greater as P is greater in respect of n. P is nothing at the vertex, and increases along with the angle MTP; and when this is a right angle, P is infinite. The trajectory in a resisting medium will come therefore to deviate infinitely from a parabola, and may even deviate farther from it than the parabola deviates from a straight line. That is, the distance of the body in a given moment from that point of its parabolic path where it would have been in a void, is greater than the distance between that point of the parabola from the point of the straight line where it would have been, independent of the action of gravity. This must happen whenever the resistance is greater than the weight of the body, which is generally the case in the beginning of the trajectory in military projectiles; and this (were it now necessary) is enough to show the inutility of the parabolic theory.

83 Several properties of it ascertained.

Although we have no method of describing this trajectory, which would be received by the ancient geometers, we may ascertain several properties of it, which will assist us in the solution of the problem. In particular, we can assign the absolute length of any part of it by means of the logistic curve. For because P $=\int \dot{p}\sqrt{1+p^2}$, we have $\dot{p}\sqrt{1+p^2}=\dot{P}$, and therefore z, which was $=a\times\int\frac{\dot{p}\sqrt{1+p^2}}{\int\dot{p}\sqrt{1+p^2}}+C$, or $=a\times\int\frac{\dot{P}}{n+P}$, may be expressed by logarithms; or $z=a\times$ hyp. log. of $\frac{n+P}{n}$, since at the vertex A, where z must be $=o$, P is also $=o$.

Being able, in this way, to ascertain the length AM of the curve (counted from the vertex), corresponding to any inclination p of the tangent at its extremity M, we can ascertain the length of any portion of it, such as Mm, by first finding the length of the part Am, and then of the part AM. This we do more expeditiously thus: Let p express the position of the tangent in M, and q its position at m; then $AM=a\times$ log. $\frac{n+P}{n}$ and Am $=a\times$log. $\frac{n+Q}{n}$, and therefore Mm is $=a\times$ log. $\frac{n+Q}{n+P}$. Thus we can find the values of a great number of small portions, and the inclination of the tangents at their extremities. Then to each of these portions we can assign its proportion of the abciss and ordinate, without having recourse to the values of x and y. For the portion of abscis corresponding to the arch Mm, whose

whose middle point is inclined to the horizon in the angle b, will be $Mm \times$ cosine b, and the corresponding portion of the ordinate will be $Mm \times$ sin. b. Then we obtain the velocity in each part of the curve by the equation $h = \frac{\frac{1}{2}a \times 1+p^2}{n+p}$; or, more directly the velocity v at M will be $= \sqrt{ag}\,\frac{\sqrt{1+p^2}}{\sqrt{n+P}}$. Lastly, divide the length of the little arch by this, and the quotient will be the time of describing Mm very nearly. Add all these together, and we obtain the whole time of describing the arch AM, but a little too great, because the motion in the small arch is not perfectly uniform. The error, however, may be as small as we please, because we may make the arch as small as we please; and for greater accuracy, it will be proper to take the p by which we compute the velocity, a medium between the p for the beginning and that for the end of the arch.

84 Euler's method preferred.

This is the method followed by Euler, who was one of the most expert analysts, if not the very first, in Europe. It is not the most elegant, and the methods of some other authors, who approximate directly to the areas of the curves which determine the values of x and y, have a more scientific appearance; but they are not ultimately very different: For, in some methods, these areas are taken piecemeal, as Euler takes the arch; and by the methods of others, who give the value of the areas by Newton's method of describing a curve of the parabolic kind through any number of given points, the ordinates of these curves, which express x and y, must be taken singly, which amounts to the same thing, with the great disadvantage of a much more complicated calculus, as any one may see by comparing the expressions of x and y with the expression of z. As to those methods which approximate directly to the areas or values of x and y by an infinite series, they all, without exception, involve us in most complicated expressions, with coefficients of sines and tangents, and ambiguous signs, and engage us in a calculation almost endless. And we know of no series which converges fast enough to give us tolerable accuracy, without such a number of terms as is sufficient to deter any person from the attempt. The calculation of the arches is very moderate, so that a person tolerably versant in arithmetical operations may compute an arch with its velocity and time in about five minutes. We have therefore no hesitation in preferring this method of Euler's to all that we have seen, and therefore proceed to determine some other circumstances which render its application more general.

85 Its application made more general.

If there were no resistance, the smallest velocity would be at the vertex of the curve, and it would immediately increase by the action of gravity conspiring (in however small degree) with the motion of the body. But in a resisting medium, the velocity at the vertex is diminished by a quantity to which the acceleration of gravity in that point bears no assignable proportion. It is therefore diminished, upon the whole, and the point of smallest velocity is a little way beyond the vertex. For the same reasons, the greatest curvature is a little way beyond the vertex. It is not very material for our present purpose to ascertain the exact positions of those points.

The velocity in the descending branch augments continually: but it cannot exceed a certain limit, if the velocity at the vertex has been less than the terminal velocity; for when the curve is infinite, p is also infinite, and $h = \frac{\frac{1}{2}ap^2}{P}$, because n in this case is nothing in respect of P, which is infinite; and because p is infinite, the number hyp. log. $p+\sqrt{1+p^2}$, though infinite, vanishes in comparison with $p \times \sqrt{1+p^2}$; so that in this case $P = \frac{1}{2}p^2$, and $h = a$, and $v =$ the terminal velocity.

If, on the other hand, the velocity at the vertex has been greater than the terminal velocity, it will diminish continually, and when the curve has become infinite, v will be equal to the terminal velocity.

In either case we see that the curve on this side will have a perpendicular asymptote. It would require a long and pretty intricate analysis to determine the place of this asymptote, and it is not material for our present purpose. The place and position of the other asymptote LO is of the greatest moment. It evidently distinguishes the kind of trajectory from any other. Its position depends on this circumstance, that if p marks the position of the tangent, $n-P$, which is the denominator of the fraction expressing the square of the velocity, must be equal to nothing, because the velocity is infinite: therefore, in this place, $P = n$, or $n = \frac{1}{2}p\sqrt{1+p^2} + \frac{1}{2}\log. p+\sqrt{1+p^2}$. In order, therefore, to find the point L, where the asymptote LO cuts the horizontal line AL, put $P = n$, then will $AL = x - \frac{y\dot{x}}{\dot{y}} = a \times \left(f\frac{\dot{p}}{n-P} - \frac{1}{p}f\frac{p\dot{p}}{n-P}\right)$.

Through the whole of this article f means *fluent*.

It is evident that the logarithms used in these expressions are the natural or hyperbolic. But the operations may be performed by the common tables by making the value of the arch Mm of the curve $= \frac{a}{M} \times \log. \frac{n+Q}{n+P}$ &c. where M means the subtangent of the common logarithms, or 0,43429; also the time of describing this arch will be expeditiously had by taking a medium μ between the values of $\frac{\sqrt{1+p^2}}{\sqrt{n+P}}$ and $\frac{\sqrt{1+q^2}}{\sqrt{n+Q}}$, and making the time $= \frac{\sqrt{a}}{M\sqrt{g}} \times \log. \frac{n+Q}{n+P}$.

86 Mode of applying this process in practice.

Such then is the process by which the form and magnitude of the trajectory, and the motion in it, may be determined. But it does not yet appear how this is to be applied to any question in practical artillery. In this process we have only learned how to compute the motion from the vertex in the descending branch till the ball has acquired a particular direction, and the motion to the vertex from a point of the ascending branch where the ball has another direction, and all this depending on the greatest velocity which the body can acquire by falling, and the velocity which it has in the vertex of the curve. But the usual question is, "What will be the motion of the ball projected in a certain direction with a certain velocity?"

The mode of application is this: Suppose a trajectory computed for a particular terminal velocity, produced by the fall a, and for a particular velocity at the vertex,

which will be characterized by n, and that the velocity at that point of the afcending branch where the inclination of the tangent is 30° is 900 feet *per* fecond. Then, we are certain that if a ball, whofe terminal velocity is that produced by the fall a, be projected with the velocity of 900 feet per fecond, and an elevation of 30°, it will defcribe this very trajectory, and the velocity and time correfponding to every point will be fuch as is here determined.

Now this trajectory will, in refpect to form, anfwer an infinity of cafes: for its characteriftic is the proportion of the velocity in the vertex to the terminal velocity. When this proportion is the fame, the number n will be the fame. If therefore we compute the trajectories for a fufficient variety of thefe proportions, we fhall find a trajectory that will nearly correfpond to any cafe that can be propofed; and an approximation fufficiently exact will be had by taking a proportional medium between the two trajectories which come neareft to the cafe propofed.

87 Computed tables or trajectories.

Accordingly, a fet of tables or trajectories have been computed by the Engliih tranflator of Euler's Commentary on Robins's Gunnery. They are in number 18, diftinguifhed by the pofition of the affymptote of the afcending branch. This is given for 5°, 10°, 15°, &c. to 85°, and the whole trajectory is computed as far as it can ever be fuppofed to extend in practice. The following table gives the value of the number n correfponding to each pofition of the affymptote.

OLB	n	OLB	n
0	0,00000	45	1,14779
5	0,08760	50	1,43236
10	0,17724	55	1,82207
15	0,27712	60	2,39033
20	0,37185	65	3,29040
25	0,48269	70	4,88425
30	0,60799	75	8,22357
35	0,75382	80	17,54793
40	0,92914	85	67,12291

Since the path of a projectile is much lefs incurvated, and more rapid in the afcending than in the defcending branch, and the difference is fo much the more remarkable in great velocities; it muft follow, that the range on a horizontal or inclined plane depends moft on the afcending branch: therefore the greateft range will not be made with that elevation which bifects the angle of pofition, but with a lower elevation; and the deviation from the bifecting elevation will be greater as the initial velocities are greater. It is very difficult to frame an exact rule for determining the elevation which gives the greateft range. We have fubjoined a little table which gives the proper elevations (nearly) correfponding to the different initial velocities.

It was computed by the following approximation, which will be found the fame with the feries ufed by Newton in his Approximations.

Let e be the angle of elevation, a the height producing the terminal velocity, b the height producing the initial velocity, and c the number whofe hyperbolic logarithm is 1 (*i. e.* the number 2,718). Then,

$$y = x \times \left(\text{tan. } e + \frac{a}{2b \cdot \text{cof. } e}\right) - \frac{a^2}{2b}\left(C^{\frac{x}{a \cdot \text{cof. } e}} - 1\right),$$

&c. Make $y = v$, and take the maximum by varying e, we obtain $\frac{1}{\text{Sin.}^2 e + \frac{a \cdot \text{fin. } e}{2b}} = \text{hyperbol. log.} \left(1 + \frac{2b}{a \text{ fine } e}\right)$, which gives us the angle e.

The numbers in the firft column, multiplied by the terminal velocity of the projectile, give us the initial velocity; and the numbers in the laft column, being multiplied by the height producing the terminal velocity, and by 2,3026, give us the greateft ranges. The middle column contains the elevation. The table is not computed with fcrupulous exactnefs, the queftion not requiring it. It may however be depended on within one part of 2000.

To make ufe of this table, divide the initial velocity by the terminal velocity u, and look for the quotient in the firft column. Oppofite to this will be found the elevation giving the greateft range; and the number in the laft column being multiplied by $2,3026 \times a$ (the height producing the terminal velocity) will give the range.

Table of Elevations giving the greateft Range.

Initial vel. u	Elevation.	Range. $2,3026a^2$
0,6909	43°.40′	0,1751
0,7820	43 .20	0,2169
0,8645	42 .50	0,2548
1,3817	41 .40	0,4999
1,5641	40 .20	0,5789
1,7291	40 .10	0,6551
2,0726	39 .50	0,7877
2,3461	37 .20	0,8967
2,5936	35 .50	0,9752
2,7635	35 .—	1,0319
3,1281	34 .40	1,1411
3,4544	34 .20	1,2298
3,4581	34 .20	1,2277
3,9101	33 .50	1,3371
4,1452	33 .30	1,3901
4,3227	33 .30	1,4274
4,6921	31 .50	1,5050
4,8361	31 .50	1,5341

88 Advantage to be derived from the folution of the problem.

Such is the folution which the prefent ftate of our mathematical knowledge enables us to give of this celebrated problem. It is exact in its principle, and the application of it is by no means difficult, or even operofe. But let us fee what advantage we are likely to derive from it.

In the firft place, it is very limited in its application. There are few circumftances of general coincidence, and almoft every cafe requires an appropriated calculus. Perhaps the only general rules are the two following:

1. Balls of equal denfity, projected with the fame elevation, and with velocities which are as the fquare-roots of their diameters, will defcribe fimilar curves.—This is evident, becaufe, in this cafe, the refiftance will be in the ratio of their quantities of motion. Therefore all

all the homologous lines of the motion will be in the proportion of the diameters.

2. If the initial velocities of balls projected with the ſame elevation are in the inverſe ſubduplicate ratio of the whole reſiſtances, the ranges, and all the homologous lines of their track, will be inverſely as thoſe reſiſtances.

Theſe theorems are of conſiderable uſe: for by means of a proper ſeries of experiments on one ball projected with different elevations and velocities, tables may be conſtructed which will aſcertain the motions of an infinity of others.

89 Shown from various conſiderations to be very little.

But when we take a retroſpective view of what we have done, and conſider the conditions which were aſſumed in the ſolution of the problem, we ſhall find that much yet remains before it can be rendered of great practical uſe, or even ſatisfy the curioſity of the man of ſcience. The reſiſtance is all along ſuppoſed to be in the duplicate ratio of the velocity; but even theory points out many cauſes of deviation from this law, ſuch as the preſſure and condenſation of the air, in the caſe of very ſwift motions; and Mr Robins's experiments are ſufficient to ſhow us that the deviations muſt be exceedingly great in ſuch caſes. Mr Euler and all ſubſequent writers have allowed that it may be three times greater, even in caſes which frequently occur; and Euler gives a rule for aſcertaining with tolerable accuracy what this increaſe and the whole reſiſtance may amount to. Let H be the height of a column of air whoſe weight is equivalent to the reſiſtance taken in the duplicate ratio of the velocity. The whole reſiſtance will be expreſſed by $H + \frac{H^2}{28845}$. This number 28845 is the height in feet of a column of air whoſe weight balances its elaſticity. We ſhall not at preſent call in queſtion his reaſons for aſſigning this preciſe addition. They are rather reaſons of arithmetical convenience than of phyſical import. It is enough to obſerve, that if this meaſure of the reſiſtance is introduced into the proceſs of inveſtigation, it is totally changed; and it is not too much to ſay, that with this complication it requires the knowledge and addreſs of a Euler to make even a partial and very limited approximation to a ſolution.—Any law of the reſiſtance, therefore, which is more complicated than what Bernoulli has aſſumed, namely, that of a ſimple power of the velocity, is abandoned by all the mathematicians, as exceeding their abilities; and they have attempted to avoid the error ariſing from the aſſumption of the duplicate ratio of the velocity, either by ſuppoſing the reſiſtance throughout the whole trajectory to be greater than what it is in general, or they have divided the trajectory into different portions, and aſſigned different reſiſtances to each, which vary, through the whole of that portion, in the duplicate ratio of the velocities. By this kind of patchwork they make up a trajectory and motion which correſponds, in ſome tolerable degree, with what? With an accurate theory? No; but with a ſeries of experiments. For, in the firſt place, every theoretical computation that we make, proceeds on a ſuppoſed initial velocity; and this cannot be aſcertained with any thing approaching to preciſion, by any theory of the action of gunpowder that we are yet poſſeſſed of. In the next place, our theories of the reſiſting power of the air are entirely eſtabliſhed on the experiments on the flights of ſhot and ſhells, and are corrected and amended till they tally with the moſt approved experiments we can find. We do not learn the ranges of a gun by theory, but the theory by the range of the gun. Now the variety and irregularity of all the experiments which are appealed to are ſo great, and the acknowledged difference between the reſiſtance to ſlow and ſwift motions is alſo ſo great, that there is hardly any ſuppoſition which can be made concerning the reſiſtance, that will not agree in its reſults with many of thoſe experiments. It appears from the experiments of Dr Hutton of Woolwich, in 1784, 1785, and 1786, that the ſhots frequently deviated to the right or left of their intended track 200, 300, and ſometimes 400 yards. This deviation was quite accidental and anomalous, and there can be no doubt but that the ſhot deviated from its intended and *ſuppoſed* elevation as much as it deviated from the intended vertical plane, and this without any opportunity of meaſuring or diſcovering the deviation. Now, when we have the whole range from one to three to chooſe among for our meaſure of reſiſtance, it is evident that the confirmations which have been drawn from the ranges of ſhot are but feeble arguments for the truth of any opinion. Mr Robins finds his meaſures fully confirmed by the experiments at Metz and at Minorca. Mr Muller finds the ſame. Yet Mr Robins's meaſure both of the initial velocity and of the reſiſtance are at leaſt treble of Mr Muller's; but by compenſation they give the ſame reſults. The Chevalier Borda, a very expert mathematician, has adduced the very ſame experiments in ſupport of his theory, in which he abides by the Newtonian meaſure of the reſiſtance, which is about $\frac{1}{3}$ of Mr Robins's, and about $\frac{3}{4}$ of Muller's.

90 Cauſes of its inutility.

What are we to conclude from all this? Simply this, that we have hardly any knowledge of the air's reſiſtance, and that even the ſolution given of this problem has not as yet greatly increaſed it. Our knowledge conſiſts only in thoſe experiments, and mathematicians are attempting to patch up ſome notion of the motion of a body in a reſiſting medium, which ſhall tally with them.

There is another eſſential defect in the conditions aſſumed in the ſolution. The denſity of the air is ſuppoſed uniform; whereas we are certain that it is leſs by one fifth or one ſixth towards the vertex of the curve, in many caſes which frequently occur, than it is at the beginning and end of the flight. This is another latitude given to authors in their aſſumptions of the air's reſiſtance. The Chevalier de Borda has, with conſiderable ingenuity, accommodated his inveſtigation to this circumſtance, by dividing the trajectory into portions, and, without much trouble, has made one equation anſwer them all. We are diſpoſed to think that his ſolution of the problem (in the Memoirs of the Academy of Paris for 1769) correſponds better with the phyſical circumſtances of the caſe than any other. But his proceſs is there delivered in too conciſe a manner to be intelligible to a perſon not perfectly familiar with all the reſources of modern analyſis. We therefore preferred John Bernoulli's, becauſe it is elementary and rigorous.

After all, the practical artilleriſt muſt rely chiefly on the records of experiments contained in the books of practice

91 Neceſſity of attending to experiments.

practice at the academies, or thoſe made in a more public manner. Even a perfect theory of the air's reſiſtance can do him little ſervice, unleſs the force of gunpowder were uniform. This is far from being the caſe even in the ſame powder. A few hours of a damp day will make a greater difference than occurs in any theory; and, in ſervice, it is only by trial that every thing is performed. If the firſt ſhell falls very much ſhort of the mark, a little more powder is added; and, in cannonading, the correction is made by varying the elevation.

We hope to be forgiven by the eminent mathematicians for theſe obſervations on their theories. They by no means proceed from any diſreſpect for their labours. We are not ignorant of the almoſt inſuperable difficulty of the taſk, and we admire the ingenuity with which ſome of them have contrived to introduce into their analyſis reaſonable ſubſtitutions for thoſe terms which would render the equations intractable. But we muſt ſtill ſay, upon their own authority, that theſe are but ingenious gueſſes, and that experiment is the touchſtone by which they mould theſe ſubſtitutions; and when they have found a coincidence, they have no motive to make any alteration. Now, when we have ſuch a latitude for our meaſure of the air's reſiſtance, that we may take it of any value, from one to three, it is no wonder that compenſations of errors ſhould produce a coincidence; but where is the coincidence? The theoriſt *ſuppoſes* the ball to ſet out with a certain velocity, and his theory gives a certain range; and this range agrees with obſervation—but how? Who knows the velocity of the ball in the experiment? This is concluded from a theory incomparably more uncertain than that of the motion in a reſiſting medium.

The experiments of Mr Robins and Dr Hutton ſhow, in the moſt incontrovertible manner, that the reſiſtance to a motion exceeding 1100 feet in a ſecond, is almoſt *three times* greater than in the duplicate ratio to the reſiſtance to moderate velocities. Euler's tranſlator, in his compariſon of the author's trajectories with experiment, ſuppoſes it to be *no* greater. Yet the coincidence is very great. The ſame may be ſaid of the Chevalier de Borda's. Nay, the ſame may be ſaid of Mr Robins's own practical rules: for he makes his F, which correſponds to our *a*, almoſt double of what theſe authors do, and yet his rules are confirmed by practice. Our obſervations are therefore well founded.

92 The theory is ſtill of ſome uſe in practice,

But it muſt not be inferred from all this, that the phyſical theory is of no uſe to the practical artilleriſt. It plainly ſhows him the impropriety of giving the projectile an enormous velocity. This velocity is of no effect after 200 or 300 yards at fartheſt, becauſe it is ſo rapidly reduced by the prodigious reſiſtance of the air. Mr Robins has deduced ſeveral practical maxims of the greateſt importance from what we already know of this ſubject, and which could hardly have been even conjectured without this knowledge. See GUNNERY.

93 And may be brought to greater perfection.

And it muſt ſtill be acknowledged, that this branch of phyſical ſcience is highly intereſting to the philoſopher; nor ſhould we deſpair of carrying it to greater perfection. The defects ariſe almoſt entirely from our ignorance of the law of variation of the air's reſiſtance. Experiments may be contrived much more conducive to our information here than thoſe commonly reſorted to. The oblique flights of projectiles are, as we have ſeen, of very complicated inveſtigation, and ill fitted for inſtructing us; but numerous and well contrived experiments on the perpendicular aſcents are of great ſimplicity, being affected by nothing but the air's reſiſtance. To make them inſtructive, we think that the following plan might be purſued. Let a ſet of experiments be premiſed for aſcertaining the initial velocities. Then let ſhells be diſcharged perpendicularly with great varieties of denſity and velocity, and let nothing be attended to but the height and the time; even a conſiderable deviation from the perpendicular will not affect either of theſe circumſtances, and the effect of this circumſtance can eaſily be computed. The height can be aſcertained with ſufficient preciſion for very valuable information by their light or ſmoke. It is evident that theſe experiments will give *direct* information of the air's retarding force; and every experiment gives us two meaſures, viz. the aſcent and deſcent: and the compariſon of the times of aſcent and deſcent, combined with the obſerved height in one experiment made with a great initial velocity, will give us more information concerning the air's reſiſtance than 50 ranges. If we ſhould ſuppoſe the reſiſtance as the ſquare of the velocity, this compariſon will give in each experiment an exact determination of the initial and final velocities, which no other method can give us. Theſe, with experiments on the *time* of horizontal flights, with known initial velocities, will give us more inſtruction on this head than any thing that has yet been done; and till ſomething of this kind is carefully done, we preſume to ſay that the motion of bodies in a reſiſting medium will remain in the hands of the mathematicians as a matter of curious ſpeculation. In the mean time, the rules which Mr Robins has delivered in his Gunnery are very ſimple and eaſy in their uſe, and ſeem to come as near the truth as any we have met with. He has not informed us upon what principles they are founded, and we are diſpoſed to think that they are rather empirical than ſcientific. But we profeſs great deference for his abilities and penetration, and doubt not but that he had framed them by means of as ſcientific a diſcuſſion as his knowledge of this new and difficult ſubject enabled him to give it.

95 Tables calculated on the preceding principles.

We ſhall conclude this article, by giving two or three tables, computed from the principles eſtabliſhed above, and which ſerve to bring into one point of view the chief circumſtances of the motion in a reſiſting medium. Although the reſult of much calculation, as any perſon who conſiders the ſubject will readily ſee, they muſt not be conſidered as offering any very accurate reſults; or that, in compariſon with one or two experiments, the differences ſhall not be conſiderable. Let any perſon peruſe the publiſhed regiſters of experiments which have been made with every attention, and he will ſee ſuch enormous irregularities, that all expectations of perfect agreement with them muſt ceaſe. In the experiments at Woolwich in 1735, which were continued for ſeveral days, not only do the experiments of one day differ among themſelves, but the mean of all the experiments of one day differs from the mean of all the experiments of another no leſs than one fourth of the whole. The experiments in which the greateſt regularity may be expected, are thoſe made with great elevations. When the elevation is ſmall, the

range

range is more affected by a change of velocity, and ſtill more by any deviation from the ſuppoſed or intended direction of the ſhot.

The firſt table ſhows the diſtance in yards to which a ball projected with the velocity 1600 will go, while its velocity is reduced one tenth, and the diſtance at which it drops 16 feet from the line of its direction. This table is calculated by the reſiſtance obſerved in Mr Robins's experiments. The firſt column is the weight of the ball in pounds. The ſecond column remains the ſame whatever be the initial velocity; but the third column depends on the velocity. It is here given for the velocity which is very uſual in military ſervice, and its uſe is to aſſiſt us in directing the gun to the mark.—If the mark at which a ball of 24 pounds is directed is 474 yards diſtant, the axis of the piece muſt be pointed 16 feet higher than the mark. Theſe deflections from the line of direction are nearly as the ſquares of the diſtances.

I.	II.	III.
2	92	420
4	121	428
9	159	456
18	200	470
32	272	479

The next table contains the ranges in yards of a 24 pound ſhot, projected at an elevation of 45°, with the different velocities in feet per ſecond, expreſſed in the firſt column. The ſecond column contains the diſtances to which the ball would go in vacuo in a horizontal plane; and the third contains the diſtances to which it will go through the air. The fourth column is added, to ſhow the height to which it riſes in the air; and the fifth ſhows the ranges corrected for the diminution of the air's denſity as the bullet aſcends, and may therefore be called the *corrected range*.

I.	II.	III.	IV.	V.
200	416	349	106	360
400	1664	1121	338	1150
600	3740	1812	606	1859
800	6649	2373	866	2435
1000	10390	2845	1138	2919
1200	14961	3259	1378	3343
1400	20364	3640	1606	3734
1600	26597	3950	1814	4050
1800	33663	4235	1992	4345
2000	41559	4494	2168	4610
2200	50286	4720	2348	4842
2400	59846	4917	2460	5044
2600		5106	2630	5238
2800		5293	2762	5430
3000		5455	2862	5596
3200				5732

95 Uſe of the laſt table.

The initial velocities can never be puſhed as far as we have calculated for in this table; but we mean it for a table of more extenſive uſe than appears at firſt ſight. Recollect, that while the proportion of the velocity at the vertex to the terminal velocity remains the ſame, the curves will be ſimilar: therefore, if the initial velocities are as the ſquare-roots of the diameters of the balls, they will deſcribe ſimilar curves, and the ranges will be as the diameters of the balls.

Therefore, to have the range of a 12 pound ſhot, if projected at an elevation of 45, with the velocity 1500; ſuppoſe the diameter of the 12 pounder to be d, and that of the 24 pounder D; and let the velocities be v and V: Then ſay, $\sqrt{d} : \sqrt{D} = 1500$, to a fourth proportional V. If the 24 pounder be projected with the velocity V, it will deſcribe a curve ſimilar to that deſcribed by the 12 pounder, having the initial velocity 1500. Therefore find (by interpolation) the range of the 24 pounder, having the initial velocity V. Call this R. Then $D : d = R : r$, the range of the 12 pounder which was wanted, and which is nearly 3380 yards.

We ſee by this table the immenſe difference between the motions through the air and in a void. We ſee that the ranges through the air, inſtead of increaſing in the duplicate ratio of the initial velocities, really increaſe ſlower than thoſe velocities in all caſes of military ſervice; and in the moſt uſual caſes, viz. from 800 to 1600, they increaſe nearly as the ſquare-roots of the velocities.

A ſet of ſimilar tables, made for different elevations, would almoſt complete what can be done by theory, and would be much more expeditious in their uſe than Mr Euler's Trajectories, computed with great labour by his Engliſh tranſlator.

The ſame table may alſo ſerve for computing the ranges of bomb-ſhells. We have only to find what muſt be the initial velocity of the 24 pound ſhot which correſponds to the propoſed velocity of the ſhell. This muſt be deduced from the diameter and weight of the ſhell, by making the velocity of the 24 pounder ſuch, that the ratio of its weight to the reſiſtance may be the ſame as in the ſhell.

That the reader may ſee with one glance the relation of thoſe different quantities, we have given this table, expreſſed in a figure (fig. 10). The abſciſſa, or axis DA, is the ſcale of the initial velocities in feet per ſecond, meaſured on a ſcale of 400 equal parts in an inch. The ordinates to the curve ACG expreſs the yards of the range on a ſcale containing 800 yards in an inch. The ordinates to the curve A $\times\gamma$ expreſs (by the ſame ſcale) the height to which the ball riſes in the air. Plate CCCCXVIII. 96 Relation of the different quantities in it.

The ordinate BC (drawn through the point of the abſciſſa which correſponds to the initial velocity 2000) is divided in the points 4, 9, 12, 18, 24, 32, 42, in the ratio of the diameters of cannon-ſhot of different weights; and the ſame ordinate is produced on the other ſide of the axis, till BO be equal to BA; and then BO is divided in the ſubduplicate ratio of the ſame diameters. Lines are drawn from the point A, and from any point D of the abſciſſa, to theſe diviſions.

We ſee diſtinctly by this figure how the effect of the initial velocity gradually diminiſhes, and that in very great velocities the range is very little increaſed by its augmentation. The dotted curve APQR, ſhows what the ranges in vacuo would be.

By this figure may the problems be ſolved. Thus, to find the range of the 12 pounder, with the initial

velocity 1500. Set off 1500 from B to F; draw FH parallel to the axis, meeting the line 12A in H; draw the ordinate HK; draw KL parallel to the axis, meeting 24 B in L; draw the ordinate LM, cutting 12 B in N. MN is the range required.

If curves, such as ACG, were laid down in the same manner for other elevations, all the problems might be solved with great dispatch, and with much more accuracy than the theory by which the curves are drawn can pretend to.

PROJECTION OF THE SPHERE.

Stereographic Projection of the Sphere.

THE PROJECTION of the SPHERE is a perspective representation of the circles on the surface of the sphere; and is variously denominated according to the different positions of the eye and plane of projection.

There are three principal kinds of projection; the *stereographic*, the *orthographic*, and *gnomonic*. In the stereographic projection the eye is supposed to be placed on the surface of the sphere; in the orthographic it is supposed to be at an infinite distance; and in the gnomonic projection the eye is placed at the centre of the sphere. Other kinds of projection are, the *globular*, *Mercator's*, *scenographic*, &c. for which see the articles GEOGRAPHY, NAVIGATION, PERSPECTIVE, &c.

DEFINITIONS.

1. The plane upon which the circles of the sphere are described, is called the *plane of projection*, or the *primitive circle*. The pole of this circle is the *pole of projection*, and the place of the eye is the *projecting point*.

2. The *line of measures* of any circle of the sphere is that diameter of the primitive, produced indefinitely, which passes through the centre of the projected circle.

AXIOM.

The projection, or representation of any point, is where the straight line drawn from it to the projecting point intersects the plane of projection.

SECTION I.

Of the Stereographic Projection of the Sphere.

IN the stereographic projection of the sphere, the eye is placed on the surface of the sphere in the pole of the great circle upon which the sphere is to be projected. The projection of the hemisphere opposite to the eye falls within the primitive, to which this projection is generally limited: it, however, may be extended to the other hemisphere, or that wherein the eye is placed, the projection of which falls without the primitive.

As all circles in this projection are projected either into circles or straight lines, which are easily described, it is therefore more generally understood, and by many preferred to the other projections.

PROPOSITION I. THEOREM I.

Every great circle which passes through the projecting point is projected into a straight line passing through the centre of the primitive; and every arch of it, reckoned from the other pole of the primitive, is projected into its semitangent.

Let ABCD (fig. 1.) be a great circle passing thro' A, C, the poles of the primitive, and intersecting it in the line of common section BED, E being the centre of the sphere. From A, the projecting point, let there be drawn straight lines AP, AM, AN, AQ, to any number of points P, M, N, Q, in the circle ABCD: these lines will intersect BED, which is in the same plane with them. Let them meet it in the points *p*, *m*, *n*, *q*; then *p*, *m*, *n*, *q*, are the projections of P, M, N, Q: hence the whole circle ABCD is projected into the straight line BED, passing through the centre of the primitive. Stereographic Projection of the Sphere. Plate CCCCXIX.

Again, because the pole C is projected into E, and the point M into *m*; therefore the arch CM is projected into the straight line E*m*, which is the semitangent of the arch CM to the radius AE. In like manner, the arch CP is projected into its semitangent E*p*, &c.

COROLLARIES.

1. Each of the quadrants contiguous to the projecting point is projected into an indefinite straight line, and each of those that are remote into a radius of the primitive.

2. Every small circle which passes through the projecting point is projected into that straight line which is its common section with the primitive.

3. Every straight line in the plane of the primitive, and produced indefinitely, is the projection of some circle on the sphere passing through the projecting point.

4. The projection of any point in the surface of the sphere, is distant from the centre of the primitive, by the semitangent of the distance of that point from the pole opposite to the projecting point.

PROPOSITION II. THEOREM II.

Every circle on the sphere which does not pass through the projecting point is projected into a circle.

If the given circle be parallel to the primitive, then a straight line drawn from the projecting point to any point in the circumference, and made to revolve about the circle, will describe the surface of a cone; which being cut by the plane of projection parallel to the base, the section will be a circle. See *CONIC-Sections*.

But if the circle MN (fig. 2.) be not parallel to the primitive circle BD, let the great circle ABCD, passing through the projecting point, cut it at right angles in the diameter MN, and the primitive in the diameter BD. Through M, in the plane of the great circle, let MF be drawn parallel to BD; let AM, AN be joined, and

Stereographic Projection of the Sphere.

and meet BD in *m*. *n*. Then, because AB, AD are quadrants, and BD, MF parallel, the arch AM is equal to AF, and the angle AMF or A*mn* is equal to ANM. Hence the conic surface described by the revolution of AM about the circle MN is cut by the primitive in a subcontrary position; therefore the section is in this case likewise a circle.

COROLLARIES.

1. The centres and poles of all circles parallel to the primitive have their projections in its centre.

2. The centre and poles of every circle inclined to the primitive have their projections in the line of measures.

3. All projected great circles cut the primitive in two points diametrically opposite; and every circle in the plane of projection, which passes through the extremities of a diameter of the primitive, or through the projections of two points that are diametrically opposite on the sphere, is the projection of some great circle.

4. A tangent to any circle of the sphere, which does not pass through the projecting point, is projected into a tangent to that circle's projection; also, the circular projections of tangent circles touch one another.

5. The extremities of the diameter, on the line of measures of any projected circle, are distant from the centre of the primitive by the semitangents of the least and greatest distances of the circle on the sphere, from the pole opposite to the projecting point.

6. The extremities of the diameter, on the line of measures of any projected great circle, are distant from the centre of the primitive by the tangent and cotangent of half the great circle's inclination to the primitive.

7. The radius of any projected circle is equal to half the sum, or half the difference of the semitangents of the least and greatest distances of the circle from the pole opposite to the projecting point, according as that pole is within or without the given circle.

PROPOSITION III. THEOREM III.

An angle formed by two tangents at the same point in the surface of the sphere, is equal to the angle formed by their projections.

Plate CCCCXIX

Let FGI and GH (fig. 3.) be the two tangents, and A the projecting point; let the plane AGF cut the sphere in the circle AGL, and the primitive in the line BML. Also, let MN be the line of common section of the plane AGH with the primitive: then the angle FGH=LMN. If the plane FGH be parallel to the primitive BLD, the proposition is manifest. If not, through any point K in AG produced, let the plane FKH, parallel to the primitive, be extended to meet FGH in the line FH. Then, because the plane AGF meets the two parallel planes BLD, FKH, the lines of common section LM, FK are parallel; therefore the angle AML=AKF. But since A is the pole of BLD, the chords, and consequently the arches AB AL, are equal, and the arch ABG is the sum of the arches AL, BG; hence the angle AML is equal to an angle at the circumference standing upon AG, and therefore equal to AGI or FGK; consequently the angle FGK=FKG, and the side FG=FK. In like manner HG=HK: hence the triangles GHF, KHF are equal, and the angle FGH=FKH=LMN.

Stereographic Projection of the Sphere.

COROLLARIES.

1. An angle contained by any two circles of the sphere is equal to the angle formed by their projections. For the tangents to these circles on the sphere are projected into straight lines, which either coincide with, or are tangents to, their projections on the primitive.

2. An angle contained by any two circles of the sphere is equal to the angle formed by the radii of their projections at the point of intersection.

PROPOSITION IV. THEOREM IV.

The centre of a projected great circle is distant from the centre of the primitive; the tangent of the inclination of the great circle to the primitive, and its radius, is the secant of its inclination.

Let MNG (fig. 4.) be the projection of a great circle, meeting the primitive in the extremities of the diameter MN, and let the diameter BD, perpendicular to MN, meet the projection in F, G. Bisect FG in H, and join NH. Then, because any angle contained by two circles of the sphere is equal to the angle formed by the radii of their projections at the point of intersection; therefore the angle contained by the proposed great circle and the primitive is equal to the angle ENH, of which EH is the tangent, and NH the secant, to the radius of the primitive.

COROLLARIES.

1. All circles which pass through the points M, N are the projections of great circles, and have their centres in the line BG; and all circles which pass through the points F, G are the projections of great circles, and have their centres in the line HI, perpendicular to BG.

2. If NF, NH be continued to meet the primitive in L, F; then BL is the measure of the great circle's inclination to the primitive; and MT=2BL.

PROPOSITION V. THEOREM V.

The centre of projection of a less circle perpendicular to the primitive, is distant from the centre of the primitive, the secant of the distance of the less circle from its nearest pole; and the radius of projection is the tangent of that distance.

Let MN (fig. 5.) be the given less circle perpendicular to the primitive, and A the projecting point. Draw AM, AN to meet the diameter BD produced in G and H; then GH is the projected diameter of the less circle: bisect GH in C, and C will be its centre; join NE, NC. Then because AE, NI are parallel, the angle INE=NEA; but NEA=2NMA =2NHG=NCG: hence ENC=INE+INC=NCG +INC= a right angle; and therefore NC is a tangent to the primitive at N; but the arch ND is the distance of the less circle from its nearest pole D: hence NC is the tangent, and EC the secant of the distance of the less circle from its pole to the radius of the primitive.

Stereographic Projection of the Sphere.

Proposition VI. Theorem VI.

The projection of the poles of any circle, inclined to the primitive, are, in the line of measures, distant from the centre of the primitive, the tangent, and cotangent, of half its inclination.

Plate CCCCXIX.

Let MN (fig. 6.) be a great circle perpendicular to the primitive ABCD, and A the projecting point; then P, *p* are the poles of MN, and of all its parallels *m n*, &c. Let AP, A*p* meet the diameter BD in F*f*, which will therefore be the projected poles of MN and its parallels. The angle BEM is the inclination of the circle MEN, and its parallels, to the primitive: and because BC and MP are quadrants, and MC common to both; therefore PC=BM: and hence PEC is also the inclination of MN and its parallels. Now EF is the tangent of EAF, or of half the angle PEC the inclination; and E*f* is the tangent of the angle EA*f*; but EA*f* is the complement of EAF, hence E*f* is the cotangent of half the inclination.

Corollaries.

1. The projection of that pole which is nearest to the projecting point is without the primitive, and the projection of the other within.

2. The projected centre of any circle is always between the projection of its nearest pole and the centre of the primitive; and the projected centres of all circles are contained between their projected poles.

Proposition VII. Theorem VII.

Equal arches of any two great circles of the sphere will be intercepted between two other circles drawn on the sphere through the remote poles of those great circles.

Let AGB, CFD (fig. 7.) be two great circles of the sphere, whose remote poles are E, P; through which draw the great circle PBEC, and less circle PGE, intersecting the great circles AGB, CFD, in the points B, G, and D, F; then the arch BG is equal to the arch DF.

Because E is the pole of the circle AGB, and P the pole of CFD, therefore the arches EB, PD are equal; and since BD is common to both, hence the arch ED is equal to the arch PB. For the same reason, the arches EF, PG are equal; but the angle DEF is equal to the angle BPG: hence these triangles are equal, and therefore the arch DF is equal to the arch BG.

Proposition VIII. Theorem VIII.

If from either pole of a projected great circle, two straight lines be drawn to meet the primitive and the projection, they will intercept similar arches of these circles.

On the plane of projection AGB (fig. 7.) let the great circle CFD be projected into *c f d*, and its pole P into *p*; through *p* draw the straight lines *p d*, *p f*, then are the arches GB, *f d* similar.

Since *p d* lies both in the plane AGB and APBE, it is in their common section, and the point B is also in their common section; therefore *p d* passes through the point B. In like manner it may be shown that the line *p f* passes through G. Now the points D, F are projected into *d*, *f*: hence the arches FD, *f d* are similar; but GB is equal to FD, therefore the intercepted arch of the primitive GB is similar to the projected arch *f d*.

Stereographic Projection of the Sphere.

Corollary.

Hence, if from the angular point of a projected spherical angle two straight lines be drawn through the projected poles of the containing sides, the intercepted arch of the primitive will be the measure of the spherical angle.

Proposition IX. Problem I.

To describe the projection of a great circle through two given points in the plane of the primitive.

Let P and B be given points, and C the centre of the primitive.

1. When one point P (fig. 8.) is the centre of the primitive, a diameter drawn through the given points will be the great circle required.

2. When one point P (fig. 9.) is in the circumference of the primitive. Through P draw the diameter PD; and an oblique circle described through the three points P, B, D, will be the projection of the required great circle.

3. When the given points are neither in the centre nor circumference of the primitive. Through either of the given points P (fig. 10) draw the diameter ED, and at right angles thereto draw the diameter FG. From F through P draw the straight line FPH, meeting the circumference in H: draw the diameter HI, and draw the straight line FIK, meeting ED produced in D; then an arch, terminated by the circumference, being described through the three points P, B, K, will be the great circle.

Proposition X. Problem II.

To describe the representation of a great circle about any given point as a pole.

Let P be the given pole, and C the centre of the primitive.

1. When P (fig. 8.) is in the centre of the primitive, then the primitive will be the great circle required.

2. When the pole P (fig. 11.) is in the circumference of the primitive. Through P draw the diameter PE, and the diameter AB drawn at right angles to PE will be the projected great circle required.

3. When the given pole is neither in the centre nor circumference of the primitive. Through the pole P (fig. 12.) draw the diameter AB, and draw the diameter DE perpendicular to AB; through E and P draw the straight line EPF, meeting the circumference in F. Make FG equal to FD; through E and G draw the straight line EGH, meeting the diameter AB produced if necessary in H; then from the centre H, with the radius HE, describe the oblique circle DIE, and it will be the projection of the great circle required.

Plate CCCCXX.

Or, make DK equal to FA; join EK, which intersects the diameter AB in I; then through the three points D, I, E, describe the oblique circle DIE.

Proposition XI. Problem III.

To find the poles of a great circle.

1. When the given great circle is the primitive, its centre is the pole.

2. To

Stereographic Projection of the Sphere.

2. To find the pole of the right circle ACB (fig. 11.) Draw the diameter PE perpendicular to the given circle AB; and its extremities P, E are the poles of the circle ACB.

Plate CCCCXIX. Plate CCCCXX

3. To find the pole of the oblique circle DEF (fig. 13.) Join DF, and perpendicular thereto draw the diameter AB, cutting the given oblique circle DEF in E. Draw the straight line FEG, meeting the circumference in G. Make GI, GH, each equal to AD; then FI being joined, cuts the diameter AB in P, the lower pole; through F and H draw the straight line FHp, meeting the diameter AB produced in p, which will be the opposite or exterior pole.

Proposition XII. Problem IV.

To describe a less circle about any given point as a pole, and at any given distance from that pole.

1. When the pole of the less circle is in the centre of the primitive; then from the centre of the primitive, with the semitangent of the distance of the given circle from its pole, describe a circle, and it will be the projection of the less circle required.

2. If the given pole is in the circumference of the primitive, from C (fig. 14.), the centre of the primitive, set off CE the secant of the distance of the less circle from its pole P; then from the centre E, with the tangent of the given distance, describe a circle, and it will be the less circle required. Or, make PG, PF each equal to the chord of the distance of the less circle from its pole. Through B, G, draw the straight line BGD meeting CP produced in D: bisect GD in H, and draw HE perpendicular to GD; and meeting PD in E, then E is the centre of the less circle.

3. When the given pole is neither in the centre nor circumference of the primitive. Through P (fig. 15.), the given pole, and C the centre of the primitive, draw the diameter AB, and draw the diameter DE perpendicular to AB; join EP, and produce it to meet the primitive in p; make pF, pG, each equal to the chord of the distance of the less circle from its pole; join EF which intersects the diameter AB in H; from E through G draw the straight line EGI, meeting the diameter AB produced in I; bisect HI in K: Then a circle described from the centre K, at the distance KH or KI, will be the projection of the less circle.

Proposition XIII. Problem V.

To find the poles of a given less circle.

The poles of a less circle are also those of its parallel great circle. If therefore the parallel great circle be given, then its poles being found by Prob. III. will be those of the less circle. But if the parallel great circle be not given, let HMIN (fig. 15.) be the given less circle. Through its centre, and C the centre of the primitive, draw the line of measures IAHB; and draw the diameter DE perpendicular to it, also draw the straight line EHF meeting the primitive in F; make Fp equal to the chord of the distance of the less circle from its pole; join Ep, and its intersection P with the diameter AB is the interior pole. Draw the diameter pCL through E and L, draw ELq meeting the diameter AB produced in q; then q is the external pole. Or thus: Join EI intersecting the primitive in G; join also EH, and produce it to meet the primitive in F, bisect the arch GF in p; from E to p draw the straight line EPp, and P is the pole of the given less circle.

Stereographic Projection of the Sphere.

Proposition XIV. Problem VI.

To measure any arch of a great circle.

1. Arches of the primitive are measured on the line of chords.

2. Right circles are measured on the line of semitangents, beginning at the centre of the primitive. Thus, the measure of the portion AC (fig. 16.) of the right circle DE, is found by applying it to the line of semitangents. The measure of the arch DB is found by subtracting that of BC from 90°: the measure of the arch AF, lying partly on each side of the centre, is obtained by adding the measures of AC and CF. Lastly, To measure the part AB, which is neither terminated at the centre or circumference of the primitive, apply CA to the line of semitangents; then CB, and the difference between the measures of these arches, will be that of AB.

Or thus, Draw the diameter GH perpendicular to DE; then from either extremity, as D, of this diameter, draw lines through the extremities of the arch intended to be measured; and the intercepted portion of the primitive applied to the line of chords will give the measure of the required arch. Thus IK applied to the line of chords will give the measure of AB.

3. To measure an arch of an oblique circle: draw lines from its pole through the extremities of the arch to meet the primitive, then the intercepted portion of the primitive applied to the line of chords will give the measure of the arch of the oblique circle. Thus, let AB (fig. 17.), be an arch of an oblique circle to be measured, and P its pole; from P draw the lines PAD, PBE meeting the primitive in B and E; then the arch DE applied to the line of chords will give the measure of the arch of the oblique circle AB.

Proposition XV. Problem VII.

To measure any arch of a less circle.

Let DEG (fig. 18.) be the given less circle, and DE the arch to be measured: find its internal pole P; and describe the circle AFI parallel to the primitive, and whose distance from the projecting point may be equal to the distance of the given less circle from its pole P: then join PD, PE, which produce to meet the parallel circle in A and F. Now AF applied to a line of chords will give the measure of the arch DE of the given less circle.

Proposition XVI. Problem VIII.

To measure any spherical angle.

1. If the angle is at the centre of the primitive, it is measured as a plane angle.

2. When the angular point is in the circumference of the primitive; let A (fig. 19.) be the angular point, and ABE an oblique circle inclined to the primitive. Through P, the pole of ABE, draw the line APp meeting the circumference in p: then the arch Ep is the measure of the angle BAD, and the arch AFp is the measure of its supplement BAF: also pF is the measure of the angle BAC, and pED that of its supplement.

Stereographic Projection of the Sphere.

Plate CCCCXX.

3. If the angular point is neither at the centre nor circumference of the primitive. Let A (fig. 20.) be the angular point, and DAH, or GAF the angle to be measured, P the pole of the oblique circle DAF, and *p* the pole of GAH: then from A, through the points P *p*, draw the straight lines APM, A *p* N, and the arch MN will be the measure of the angle DAH; and the supplement of MN will be the measure of the angle HAF or DAG.

Proposition XVII. Problem IX.

To draw a great circle perpendicular to a projected great circle, and through a point given in it.

Find the pole of the given circle, then a great circle described through that pole and the given point will be perpendicular to the given circle. Hence if the given circle be the primitive, then a diameter drawn through the given point will be the required perpendicular. If the given circle is a right one, draw a diameter at right angles to it; then through the extremities of this diameter and the given point describe an oblique circle, and it will be perpendicular to that given. If the given circle is inclined to the primitive, let it be represented by BAD (fig. 21.), whose pole is P, and let A be the point through which the perpendicular is to be drawn: then, by Prob. I. describe a great circle through the points P and A, and it will be perpendicular to the oblique circle BAD.

Proposition XVIII. Problem X.

Through a point in a projected great circle, to describe another great circle to make a given angle with the former, provided the measure of the given angle is not less than the distance between the given point and circle.

Let the given circle be the primitive, and let A (fig. 19.) be the angular point. Draw the diameters AE, DF perpendicular to each other; and make the angle CAG equal to that given, or make CG equal to the tangent of the given angle; then from the centre G, with the distance GC, describe the oblique circle ABE, and it will make with the primitive an angle equal to that given.

If the given circle be a right one, let it be APB (fig. 22.) and let P be the given point. Draw the diameter GH perpendicular to AB; join GP, and produce it to *a*; make H *b* equal to twice A *a*; and G *b* being joined intersects AB in C. Draw CD perpendicular to AB, and equal to the cotangent of the given angle to the radius PC; or make the angle CPD equal to the complement of that given: then from the centre D, with the radius DP, describe the great circle FPE, and the angle APF, or BPE, will be equal to that given.

If APB (fig. 23.) is an oblique circle. From the angular point P, draw the lines PG, PC through the centres of the primitive and given oblique circle. Through C, the centre of APB, draw GCD at right angles to PG; make the angle GPD equal to that given; and from the centre D, with the radius DP, describe the oblique circle FPE, and the angle APF, or BPE, will be equal to that proposed.

Proposition XIX. Problem XI.

Any great circle cutting the primitive being given, to describe another great circle which shall cut the given one in a proposed angle, and have a given arch intercepted between the primitive and given circles.

Stereographic Projection of the Sphere.

Plate CCCCXXI.

If the given circle be a right one, let it be represented by APC (fig. 24.); and at right angles thereto draw the diameter BPM; make the angle BPF equal to the complement of the given angle, and PF equal to the tangent of the given arch; and from the centre of the primitive with the secant of the same arch describe the arch G *g*. Through F draw FG parallel to AC, meeting G *g* in G; then from the centre G, with the tangent PF, describe an arch *n o*, cutting APC in I, and join GI. Through G, and the centre P, draw the diameter HK; draw PL perpendicular to HK, and IL perpendicular to GI, meeting PL in L; then L will be the centre of the circle HIK, which is that required.

But if the given great circle be inclined to the primitive, let it be ADB (fig. 25.), and E its centre: make the angle BDF equal to the complement of that given, and DF equal to the tangent of the given arch, as before. From P, the centre of the primitive, with the secant of the same arch, describe the arch G *g*, and from E, the centre of the oblique circle, with the extent EF, describe an arch intersecting G *g* in G. Now G being determined, the remaining part of the operation is performed as before.

When the given arch exceeds 90°, the tangent and secant of its supplement are to be applied on the line DF the contrary way, or towards the right; the former construction being reckoned to the left.

Proposition XX. Problem XII.

Any great circle in the plane of projection being given to describe another great circle, which shall make given angles with the primitive and given circles.

Let ADC (fig. 26.) be the given circle, and Q its pole. About P, the pole of the primitive, describe an arch *m n*, at the distance of as many degrees as are in the angle which the required circle is to make with the primitive. About Q the pole of the circle ADC, and at a distance equal to the measure of the angle which the required circle is to make with the given circle ADC, describe an arch *o n*, cutting *m n* in *n*. Then about *n* as a pole, describe the great circle EDF, cutting the primitive and given circle in E and D, and it will be the great circle required.

Scholium.

It will hence be an easy matter to construct all the various spherical triangles. The reader is, however, referred to the article *Spherical* Trigonometry, for the method of constructing them agreeable to this projection; and also for the application to the resolution of problems of the sphere. For the method of projecting the sphere upon the plane of the meridian, and of the horizon, according to the stereographic projection, see the article Geography.

SECTION II.

Of the Orthographic Projection of the Sphere.

The orthographic projection of the sphere, is that in which the eye is placed in the axis of the plane of projection

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jection, at an infinite distance with respect to the diameter of the sphere; so that at the sphere all the visual rays are assumed parallel, and therefore perpendicular to the plane of projection.

Hence the orthographic projection of any point is where a perpendicular from that point meets the plane of projection: and the orthographic representation of any object is the figure formed by perpendiculars drawn from every point of the object to the plane of projection.

This method of projection is used in the geometrical delineation of eclipses, occultations, and transits. It is also particularly useful in various other projections, such as the analemma. See GEOGRAPHY, &c.

PROPOSITION I. THEOREM I.

Every straight line is projected into a straight line. If the given line be parallel to the plane of projection, it is projected into an equal straight line; but if it is inclined to the primitive, then the given straight line will be to its projection in the ratio of the radius to the cosine of inclination.

Plate CCCCXXI.

Let AB (fig. 27.) be the plane of projection, and let CD be a straight line parallel thereto: from the extremities C, D of the straight line CD, draw the lines CE, DF perpendicular to AB; then by 3. of XI. of Eucl. the intersection EF, of the plane CEFD, with the plane of projection, is a straight line: and because the straight lines CD, EF are parallel, and also CE, DF; therefore, by 34. of I. of Eucl. the opposite sides are equal; hence the straight line CD, and its projection EF, are equal. Again, let GH be the proposed straight line, inclined to the primitive; then the lines GE, HF being drawn perpendicular to AB, the intercepted portion EF will be the projection of GH. Through G draw GI parallel to AB, and the angle IGH will be equal to the inclination of the given line to the plane of projection. Now GH being the radius, GI, or its equal EF, will be the cosine of IGH; hence the given line GH is to its projection EF as radius to the cosine of inclination.

COROLLARIES.

1. A straight line perpendicular to the plane of projection is projected into a point.

2. Every straight line in a plane parallel to the primitive is projected into an equal and parallel straight line.

3. A plane angle parallel to the primitive is projected into an equal angle.

4. Any plane rectilineal figure parallel to the primitive is projected into an equal and similar figure.

5. The area of any rectilineal figure is to the area of its projection as radius to the cosine of its inclination.

PROPOSITION II. THEOREM II.

Every great circle, perpendicular to the primitive, is projected into a diameter of the primitive; and every arch of it, reckoned from the pole of the primitive, is projected into its sine.

Let BFD (fig. 28.) be the primitive, and ABCD a great circle perpendicular to it, passing through its poles A, C; then the diameter BED, which is their line of common section, will be the projection of the circle ABCD. For if from any point, as G, in the circle ABC, a perpendicular GH fall upon BD, it will also be perpendicular to the plane of the primitive: therefore H is the projection of G. Hence the whole circle is projected into BD, and any arch AG into EH equal to GI its sine.

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COROLLARIES.

1. Every arch of a great circle, reckoned from its intersection with the primitive, is projected into its versed sine.

2. Every less circle perpendicular to the primitive is projected into its line of common section with the primitive, which is also its own diameter; and every arch of the semicircle above the primitive, reckoned from the middle point, is projected into its sine.

3. Every diameter of the primitive is the projection of a great circle; and every chord the projection of a less circle.

4. A spherical angle at the pole of the primitive is projected into an equal angle.

PROPOSITION III. THEOREM III.

A circle parallel to the primitive is projected into a circle equal to itself, and concentric with the primitive.

Let the less circle FIG (fig. 29.) be parallel to the plane of the primitive BND. The straight line HE, which joins their centres, is perpendicular to the primitive; therefore E is the projection of H. Let any radii HI and IN perpendicular to the primitive be drawn. Then IN, HE being parallel, are in the same plane; therefore IH, NE, the lines of common section of the plane IE, with two parallel planes, are parallel; and the figure IHEN is a parallelogram. Hence NE = IH, and consequently FIG is projected into an equal circle KNL, whose centre is E.

COROLLARY.

The radius of the projection is the cosine of the distance of the parallel circle from the primitive, or the sine of its distance from the pole of the primitive.

PROPOSITION IV. THEOREM IV.

An inclined circle is projected into an ellipse, whose transverse axis is the diameter of the circle.

1. Let ELF (fig. 30.) be a great circle inclined to the primitive EBF, and EF their line of common section. From the centre C, and any other point K, in EF, let the perpendiculars CB, KI be drawn in the plane of the primitive, and CL, KN, in the plane of the great circle, meeting the circumference in L, N. Let LG, ND be perpendicular to CB, KI; then G, D are the projections of L, N. And because the triangles LCG, NKD are equiangular, $CL^2 : CG^2 :: NK^2 : DK^2$; or $EC^2 : CG^2 :: EKF : DK^2$: therefore the points G, D are in the curve of an ellipse, of which EF is the transverse axis, and CG the semiconjugate axis.

COROLLARIES.

1. In a projected great circle, the semiconjugate axis is the cosine of the inclination of the great circle to the primitive.

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2. Perpendiculars to the transverse axis intercept corresponding arches of the projection and the primitive.

3. The eccentricity of the projection is the sine of the inclination of the great circle to the primitive.

Plate CCCCXXI.

Case 2. Let AQB (fig. 31.) be a less circle, inclined to the primitive, and let the great circle LBM, perpendicular to both, intersect them in the lines AB, LM. From the centre O, and any other point N in the diameter AB, let the perpendiculars TOP, NQ, be drawn in the plane of the less circle, to meet its circumference in T, P, Q. Also, from the points A, N, O, B, let AG, NI, OC, BH, be drawn perpendicular to LM; and from P, Q, T, draw PE, QD, TF perpendicular to the primitive; then G, I, C, H, E, D, F, are the projections of these points. Because OP is perpendicular to LBM, and OC, PE, being perpendicular to the primitive, are in the same plane, the plane COPE is perpendicular to LBM. But the primitive is perpendicular to LBM; therefore the common section EC is perpendicular to LBM, and to LM. Hence CP is a parallelogram, and EC = OP. In like manner, FC, DI, are proved perpendicular to LM, and equal to OT, NQ. Thus, ECF is a straight line, and equal to the diameter PT. Let QR, DK be parallel to AB, LM; then RO = NQ = DI = KC, and PR × RT = EK × KF. But AO : CG : : NO : CI; therefore AO^2 : CG^2 : : QR^2 : DK^2 and EC^2 : CG^2 : : EKF : DK^2.

Corollaries.

1. The transverse axis is to the conjugate as radius to the cosine of the circle's inclination to the primitive.

2. Half the transverse axis is the cosine of half the sum of the greatest and least distances of the less circle from the primitive.

3. The extremities of the conjugate axis are in the line of measures, distant from the centre of the primitive by the cosines of the greatest and least distances of the less circle from the primitive.

4. If from the extremities of the conjugate axis of any elliptical projection perpendiculars be drawn (in the same direction if the circle do not intersect the primitive, but if otherwise in opposite directions), they will intersect an arch of the primitive, whose chord is equal to the diameter of the circle.

Proposition V. Theorem V.

The projected poles of an inclined circle are in its line of measures distant from the centre of the primitive the sine of the inclination of the circle to the primitive.

Let ABCD (fig 32.) be a great circle, perpendicular both to the primitive and the inclined circle, and intersecting them in the diameters AC, MN. Then ABCD passes through the poles of the inclined circle; let these be P, Q; and let P*p*, Q*q*, be perpendicular to AC; *p*, *q* are the projected poles; and it is evident that *p* O = sine of BP, or MA, the inclination.

Corollaries.

1. The centre of the primitive, the centre of the projection, the projected poles, and the extremities of the conjugate axis, are all in one and the same straight line.

2. The distance of the centre of projection from the centre of the primitive, is to the cosine of the distance of the circle from its own pole, as the sine of the circle's inclination to the primitive is to the radius.

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Proposition VI. Problem I.

To describe the projection of a circle perpendicular to the primitive, and whose distance from its pole is equal to a given quantity.

Let PA *p* B (fig. 33.) be the primitive circle, and P, *p* the poles of the right circle to be projected. Then if the circle to be projected is a great circle, draw the diameter AB at right angles to the axis P*p*, and it will be that required. But if the required projection is that of a less circle, make PE, PF each equal to the chord of the distance of the less circle from its pole; join EF, and it will be the projection of the less circle required.

Proposition VII. Problem II.

Through a given point in the plane of the primitive to describe the projection of a great circle, having a given inclination to the primitive.

1. When the given inclination is equal to a right angle, a straight line drawn through the centre of the primitive and the given point will be the projection required.

2. When the given inclination is less than a right angle, and the given point in the circumference of the primitive. Let R (fig. 34.) be a point given in the circumference of the primitive, through which it is required to draw the projection of a great circle, inclined to the primitive in an angle measured by the arch QP of the primitive.

Through the given point R draw the diameter RCS, and draw GC *g* at right angles to it. Make the arch GV of the primitive equal to QP, and draw VA at right angles to GC; and in G *g*, towards the opposite parts of C, take CB equal to AC; then, with the greater axis RS, and less axis AB, describe an ellipse, and it will be the projection of the oblique circle required.

3. When the distance of the given point from the primitive is equal to the cosine of the given inclination.

Every thing remaining as in the preceding case; let A be the given point, and AC the cosine of an arch GV, equal to the given arch QP; then drawing the diameter RCS at right angles to ACB, the ellipse described with the given axis RS, AB will be the projection of the inclined circle.

4. When the distance of the given point from the centre of the primitive is less than the semidiameter of the primitive, but greater than the cosine of the given inclination.

Let D be the given point, through which draw the diameter IC *i*; and at the point D draw DL perpendicular to DC meeting the primitive in L; also draw LK, making with LD the angle DLK equal to the complement of the given inclination. Let LK meet DC in K; then will DK be less than DC. On DC as a diameter describe a circle, and make DH equal to DK; through H draw a diameter of the primitive RCS, and describe an ellipse through the points R, D, S, and it will be the projection of the inclined circle.

Waller on the Sphere, p. 159.

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Proposition VIII. Problem III.

Through two given points in the plane of the primitive to describe the projection of a great circle.

1. If the two given points and the centre of the primitive be in the same straight line, then a diameter of the primitive being drawn through these points will be the projection of the great circle required.

2. When the two given points are not in the same straight line with the centre of the primitive; and one of them is in the circumference of the primitive.

Plate ccccxxi. Let D, R, (fig. 34.) be the two given points, of which R is in the circumference of the primitive. Draw the diameter RCS, and GC g, FDH perpendicular to it, meeting the primitive in G g F. Divide GC, g C, in A, B, in the same proportion as FH is divided in D; and describe the ellipse whose axes are RS, AB, and centre C; and it will be the projection required.

3. When the given points are within the primitive, and not in the same straight line with its centre.

Let D, E (fig. 35.) be the two given points; through C the centre of the primitive draw the straight lines ID i, KE i; draw DL perpendicular to I i, and EO perpendicular to K k, meeting the primitive in L, O. Through E, and towards the same parts of C, draw EP parallel to DC, and in magnitude a fourth proportional to LD, DC, OE. Draw the diameter CP meeting the primitive in R, S, and describe an ellipse through the points D and R or S, and it will also pass through E. This ellipse will be the projection of the proposed inclined circle.

Proposition IX. Problem IV.

To describe the projection of a less circle parallel to the primitive, its distance from the pole of the primitive being given.

From the pole of the primitive, with the sine of the given distance of the circle from its pole, describe a circle, and it will be the projection of the given less circle.

Proposition X. Problem V.

About a given point as a projected pole to describe the projection of an inclined circle, whose distance from its pole is given.

Let P (fig. 36.) be the given projected pole, through which draw the diameter G g, and draw the diameter H b perpendicular thereto. From P draw PL perpendicular to GP meeting the circumference in L; through which draw the diameter L l. Make LT, LK each equal to the chord of the distance of the less circle from its pole, and join TK, which intersects L l, in Q. From the points T, Q, K draw the lines FA, QS, KB, perpendicular to G g; and make OR, OS, each equal to QT, or QK. Then an ellipse described through the points A, S, B, R will be the projection of the proposed less circle.

Proposition XI. Problem VI.

To find the poles of a given projected circle.

1. If the projected circle be parallel to the primitive, the centre of the primitive will be its pole.

2. If the circle be perpendicular to the primitive, then the extremities of a diameter of the primitive drawn at right angles to the straight line representing the projected circle, will be the poles of that circle.

3. When the projected circle is inclined to the primitive.

Let ARBS (fig. 36, 37.) be the elliptical projection of any oblique circle; through the centre of which, and C the centre of the primitive, draw the line of measures CBA, meeting the ellipse in B, A; and the primitive in G, g. Draw CH, BK, AT perpendicular to G g, meeting the primitive in H, K, T. Bisect the arch KT in L, and draw LP perpendicular to G g; then P will be the projected pole of the circle, of which ARBS is the projection.

Proposition XII. Problem VII.

To measure any portion of a projected circle, and conversely.

1. When the given projection is that of a great circle.

Let ADEB (fig. 38.) be the given great circle, either perpendicular or inclined to the primitive, of which the portion DE is to be measured, and let M m be the line of measures of the given circle. Through the points D, E draw the lines EG, DF parallel to M m; and the arch FG of the primitive will be the measure of the arch DE of the great circle, and conversely.

2. When the projection is that of a less circle parallel to the primitive.

Plate ccccxxii. Let DE (fig. 39.) be the portion to be measured, of the less circle DEH parallel to the primitive. From the centre C draw the lines CD, CE, and produce them to meet the primitive in the points B, F. Then the intercepted portion BF of the primitive will be the measure of the given arch DE of the less circle DEH.

3. If the given less circle, of which an arch is to be measured, is perpendicular to the primitive.

Let ADEB (fig. 40.) be the less circle, of which the measure of the arch DE is required. Through C, the centre of the primitive, draw the line of measures M m, and from the intersection O of the given right circle, and the line of measures, with the radius OA, or OB, describe the semicircle AFGB; through the points D, E draw the lines DF, EG parallel to the line of measures, and the arch FG will be the measure of DE, to the radius AO. In order to find a similar arch in the circumference of the primitive, join OF, OG, and at the centre C of the primitive, make the angle mCH equal to FOG, and the arch mH to the radius C m will be the measure of the arch DE.

4. When the given projection is of a less circle inclined to the primitive.

Let RDS (fig. 41.) be the projection of a less circle inclined to the primitive, and DE a portion of that circle to be measured. Through O the centre of the projected circle, and C the centre of the primitive, draw the line of measures M m; and from the centre O, with the radius OR, or OS, describe the semicircle RGFS; through the points D, E draw the lines DF, EG parallel to the line of measures, and FG will be the measure of the arch DE to the radius OR, or OS. Join OF, OG, and make the angle mCH equal to FOG,

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FOG, and the arch *m* H of the primitive will be the meaſure of the arch DE of the inclined circle RDS.

The converſe of this propoſition, namely, to cut off an arch from a given projected circle equal to a given arch of the primitive, is obvious.

The above operation would be greatly ſhortened by uſing the line of ſines in the ſector.

It ſeems unneceſſary to inſiſt farther on this projection, eſpecially as the reader will ſee the application of it to the projection of the ſphere on the planes of the *Meridian*, *Equator*, and *Horizon* in the article GEOGRAPHY; and to the delineation of *Eclipſes* in the article ASTRONOMY. The *Analemma*, Plate CCXII. in the article GEOGRAPHY, is alſo according to this projection; and the method of applying it to the ſolution of aſtronomical problems is there exemplified.

SECTION III.

Of the Gnomonic Projection of the Sphere.

IN this projection the eye is in the centre of the ſphere, and the plane of projection touches the ſphere in a given point parallel to a given circle. It is named *gnomonic*, on account of its being the foundation of dialling: the plane of projection may alſo repreſent the plane of a dial, whoſe centre being the projected pole, the ſemiaxis of the ſphere will be the ſtile or gnomon of the dial.

As the projection of great circles are repreſented by ſtraight lines, and leſs circles parallel to the plane of projection are projected into concentric circles; therefore many problems of the ſphere are very eaſily reſolved. Other problems, however, become more intricate on account of ſome of the circles being projected into ellipſes, parabolas, and hyperbolas.

PROPOSITION I. THEOREM I.

Every great circle is projected into a ſtraight line perpendicular to the line of meaſures; and whoſe diſtance from the centre is equal to the cotangent of its inclination, or to the tangent of its neareſt diſtance from the pole of the projection.

Plate CCCCXXII.

Let BAD (fig. 42.) be the given circle, and let the circle CBED be perpendicular to BAD, and to the plane of projection; whoſe interſection CF with this laſt plane will be the line of meaſures. Now ſince the circle CBED is perpendicular both to the given circle BAD and to the plane of projection, the common ſection of the two laſt planes produced will therefore be perpendicular to the plane of the circle CBED produced, and conſequently to the line of meaſures: hence the given circle will be projected into that ſection; that is, into a ſtraight line paſſing through *d*, perpendicular to C*d*. Now C*d* is the cotangent of the angle C*d*A, the inclination of the given circle, or the tangent of the arch CD to the radius AC.

COROLLARIES.

1. A great circle perpendicular to the plane of projection is projected into a ſtraight line paſſing through the centre of projection; and any arch is projected into its correſpondent tangent.

2. Any point, as D, or the pole of any circle, is projected into a point *d*, whoſe diſtance from the pole of projection is equal to the tangent of that diſtance.

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3. If two great circles be perpendicular to each other, and one of them paſſes through the pole of projection, they will be projected into two ſtraight lines perpendicular to each other.

4. Hence if a great circle be perpendicular to ſeveral other great circles, and its repreſentation paſs through the centre of projection; then all theſe circles will be repreſented by lines parallel to one another, and perpendicular to the line of meaſures, for repreſentation of that firſt circle.

PROPOSITION II. THEOREM II.

If two great circles interſect in the pole of projection, their repreſentations will make an angle at the centre of the plane of projection, equal to the angle made by theſe circles on the ſphere.

For ſince both theſe circles are perpendicular to the plane of projection, the angle made by their interſections with this plane is the ſame as the angle made by theſe circles.

PROPOSITION III. THEOREM III.

Any leſs circle parallel to the plane of projection is projected into a circle whoſe centre is the pole of projection, and its radius is equal to the tangent of the diſtance of the circle from the pole of projection.

Let the circle PI (fig. 42.) be parallel to the plane GF, then the equal arches PC, CI are projected into the equal tangents GC, CH; and therefore C, the point of contact and pole of the circle PI and of the projection, is the centre of the repreſentation G, H.

COROLLARY.

If a circle be parallel to the plane of projection, and 45 degrees from the pole, it is projected into a circle equal to a great circle of the ſphere; and therefore may be conſidered as the primitive circle, and its radius the radius of projection.

PROPOSITION IV. THEOREM IV.

A leſs circle not parallel to the plane of projection is projected into a conic ſection, whoſe tranſverſe axis is in the line of meaſures; and the diſtance of its neareſt vertex from the centre of the plane of projection is equal to the tangent of its neareſt diſtance from the pole of projection; and the diſtance of the other vertex is equal to the tangent of the greateſt diſtance.

Any leſs circle is the baſe of a cone whoſe vertex is at A (fig. 43.); and this cone being produced, its interſection with the plane of projection will be a conic ſection. Thus the cone DAF, having the circle DF for its baſe, being produced, will be cut by the plane of projection in an ellipſe whoſe tranſverſe diameter is *df*; and C*d* is the tangent of the angle CAD, and C*f* the tangent of CAF. In like manner, the cone AFE, having the ſide AE parallel to the line of meaſures *df*, being cut by the plane of projection, the ſection will be a parabola, of which *f* is the neareſt vertex,

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tex, and the point into which E is projected is at an infinite distance. Also the cone AFG, whose base is the circle FG, being cut by the plane of projection, the section will be a hyperbola; of which *f* is the nearest vertex; and GA being produced gives *d* the other vertex.

COROLLARIES.

1. A less circle will be projected into an ellipse, a parabola, or hyperbola, according as the distance of its most remote point is less, equal to, or greater than, 90 degrees.

2. If H be the centre, and K, *k*, *l* the focus of the ellipse, hyperbola, or parabola; then $HK = \frac{Ad - Af}{2}$ for the ellipse; $Hk = \frac{Ad + Af}{2}$ for the hyperbola; and *f n* being drawn perpendicular to AE $fl = \frac{nE + Ff}{2}$ for the parabola.

PROPOSITION V. THEOREM V.

Plate ccccxxii.

Let the plane TW (fig. 44.) be perpendicular to the plane of projecton TV, and BCD a great circle of the sphere in the plane TW. Let the great circle BED be projected into the straight line *b e k*. Draw CQS perpendicular to *b k*, and C *m* parallel to it and equal to CA, and make QS equal to Q *m*; then any angle QS *t* is the measure of the arch Q *t* of the projected circle.

Join AQ: then because C *m* is equal to CA, the angle QC *m* equal to QCA, each being a right angle, and the side QC common to both triangles; therefore Q *m*, or its equal QS, is equal QA. Again, since the plane ACQ is perpendicular to the plane TV, and *b* Q to the intersection CQ; therefore *b* Q is perpendicular both to AQ and QS: hence, since AQ and QS are equal, all the angles at S cut the line *b* Q in the same points as the equal angles at A. But by the angles at A the circle BED is projected into the line *b* Q. Therefore the angles at S are the measures of the parts of the projected circle *b* Q; and S is the dividing centre thereof.

COROLLARIES.

1. Any great circle *b* Q *t* is projected into a line of tangents to the radius SQ.

2. If the circle *b* C pass through the centre of projection, then the projecting point A is the dividing centre thereof, and C *b* is the tangent of its correspondent arch C B to CA the radius of projection.

PROPOSITION VI. THEOREM VI.

Let the parallel circle GLH (fig. 44.) be as far from the pole of projection C as the circle FNI is from its pole; and let the distance of the poles C, P be bisected by the radius AO; and draw *b* AD perpendicular to AO; then any straight line *b* Q *t* drawn through *b* will cut off the arches *b l*, F *n* equal to each other in the representations of these equal circles in the plane of projection.

Let the projections of the less circles be described. Then, because BD is perpendicular to AO, the arches BO, DO are equal; but since the less circles are equally distant each from its respective pole, therefore the arches FO, OH are equal; and hence the arch BF is equal to the arch DH. For the same reason the arches BN, DL are equal; and the angle FBN is equal to the angle LDH; therefore, on the sphere, the arches FN, HL are equal. And since the great circle BNLD is projected into the straight line *b* Q *n l*, &c. therefore *n* is the projection of N, and *l* that of L; hence *f n*, *b l*, the projections of FN, HL respectively, are equal.

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PROPOSITION VII. THEOREM VII.

If F *n k*, *b l g* (fig 45.) be the projections of two equal circles, whereof one is as far from its pole P as the other from its pole C, which is the centre of projection; and if the distance of the projected poles C, *p* be divided in *o*, so that the degrees in C *o*, *o p* be equal, and the perpendicular *o* S be erected to the line of measures *g h*. Then the line *p n*, C *l* drawn from the poles C, *p*, through any point Q in the line *o* S, will cut off the arches F *n*, *b l* equal to each other, and to the angle Q C *p*.

The great circle AO perpendicular to the plane of the primitive is projected into the straight line *o* S perpendicular to *g h*, by Prop. i. Cor. 3. Let Q be the projection of *q*; and since *p* Q, C Q are straight lines, they are therefore the representations of the arches P *q*, C *q* of great circles. Now since P *q* C is an isosceles spherical triangle, the angles PCQ, CPQ are therefore equal; and hence the arches P *q*, C *q* produced will cut off equal arches from the given circles FI, GH, whose representations F *n*, *b l* are therefore equal: and since the angle Q C *p* is the measure of the arch *b l*, it is also the measure of its equal F *n*.

COROLLARY.

Hence, if from the projected pole of any circle a perpendicular be erected to the line of measures, it will cut off a quadrant from the representation of that circle.

PROPOSITION VIII. THEOREM VIII.

Let F *n k* (fig. 45.) be the projection of any circle FI, and *p* the projection of its pole P. If C *g* be the cotangent of CAP, and *g* B perpendicular to the line of measures *g* C, let CAP be bisected by AO, and the line *o* B drawn to any point B, and also *p* B cutting F *n k* in *d*; then the angle *g o* B is the measures of the arch F *d*.

The arch PG is a quadrant, and the angle $g\,o\,A = g\,P\,A + o\,A\,P = g\,A\,C + o\,A\,P = g\,A\,C + C\,A\,o = g\,A\,o$; therefore $g\,A = g\,o$; consequently *o* is the dividing centre of *g* B, the representation of GA; and hence, by Prop. v. the angle *g o* B is the measure of *g* B. But since *p g* represents a quadrant, therefore *p* is the pole of *g* B; and hence the great circle *p d* B passing through the pole of the circles *g* B and F *n* will cut off equal arches in both, that is, F *d* = *g* B = angle *g o* B.

COROLLARY.

The angle *g o* B is the measure of the angle *g p* B.

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For the triangle $g\,p$ B repreſents a triangle on the ſphere, wherein the arch which g B repreſents is equal to the angle which the angle p repreſents; becauſe $g\,p$ is a quadrant; therefore $g\,o$ B is the meaſure of both.

Proposition IX. Problem I.

To draw a great circle through a given point, and whoſe diſtance from the pole of projection is equal to a given quantity.

Plate cccclxxii

Let ADB (fig. 46.) be the projection, C its pole or centre, and P the point through which a great circle is to be drawn: through the points P, C draw the ſtraight line PCA, and draw CE perpendicular to it: make the angle CAE equal to the given diſtance of the circle from the pole of projection C; and from the centre C, with the radius CE, deſcribe the circle EFG: through P draw the ſtraight line PIK, touching the circle EFG in I, and it will be the projection of the great circle required.

Proposition X. Problem II.

To draw a great circle perpendicular to a great circle which paſſes through the pole of projection, and at a given diſtance from that pole.

Let ADB (fig. 46.) be the primitive, and CI the given circle: draw CL perpendicular to CI, and make the angle CLI equal to the given diſtance: then the ſtraight line KP, drawn through I parallel to CL, will be the required projection.

Proposition XI. Problem III.

At a given point in a projected great circle, to draw another great circle to make a given angle with the former; and, converſely, to meaſure the angle contained between two great circles.

Let P (fig. 47.) be the given point in the given great circle PB, and C the centre of the primitive: through the points P, C draw the ſtraight line PCG; and draw the radius of the primitive CA perpendicular thereto; join PA; to which draw AG perpendicular: through G draw BGD at right angles to GP, meeting PB in B; biſect the angle CAP by the ſtraight line AO; join BO, and make the angle BOD equal to that given; then DP being joined, the angle BPD will be that required.

If the meaſure of the angle BPD be required, from the points B, D draw the lines BO, DO, and the angle BOD is the meaſure of BPD.

Proposition XII. Problem IV.

To deſcribe the projection of a leſs circle parallel to the plane of projection, and at a given diſtance from its pole.

Let ADB (fig. 46.) be the primitive, and C its centre: ſet the diſtance of the circle from its pole, from B to H, and from H to D; and draw the ſtraight line AED, interſecting CE perpendicular to BC, in the point E: with the radius CE deſcribe the circle EFG, and it is the projection required.

Proposition XIII. Problem V.

To draw a leſs circle perpendicular to the plane of projection.

Let C (fig. 48.) be the centre of projection, and TI a great circle parallel to the propoſed leſs circle: at C make the angles ICN, TCO each equal to the diſtance of the leſs circle from its parallel great circle TI: let CL be the radius of projection, and from the extremity L draw LM perpendicular thereto; make CV equal to LM; or CF equal to CM: then with the vertex V and aſſymptotes CN, CO deſcribe the hyperbola WVK †; or, with the focus F and CV deſcribe the hyperbola, and it will be the perpendicular circle deſcribed.

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Plate cccclxxiii.

† See Conic Sections.

Proposition XIV. Problem VI.

To deſcribe the projection of a leſs circle inclined to the plane of projection.

Draw the line of meaſures $d\,p$ (fig. 49.) and at C, the centre of projection, draw CA perpendicular to $d\,p$, and equal to the radius of projection: with the centre A, and radius AC, deſcribe the circle DCFG; and draw RAE parallel to $d\,p$: then take the greateſt and leaſt diſtances of the circle from the pole of projection, and ſet them from C to D and F reſpectively, for the circle DF; and from A, the projecting point, draw the ſtraight lines AF f, and AD d; then $d\,f$ will be the tranſverſe axis of the ellipſe: but if D fall beyond the line RE, as at G, then from G draw the line GAD d, and $d\,f$ is the tranſverſe axis of an hyperbola: and if the point D fall in the line RE, as at E, then the line AE will not meet the line of meaſures, and the circle will be projected into a parabola whoſe vertex is f: biſect $d\,f$ in H, the centre, and for the ellipſe take half the difference of the lines A d, A f, which laid from H will give K the focus: for the hyperbola, half the ſum of A d, A f being laid from H, will give k its focus: then with the tranſverſe axis $d\,f$, and focus K, or k, deſcribe the ellipſe d M f, or hyperbola $f\,m$, which will be the projection of the inclined circle: for the parabola, make EQ equal to F f, and draw $f\,n$ perpendicular to AQ, and make $f\,k$ equal to one half of n Q: then with the vertex f, and focus k, deſcribe the parabola $f\,m$, for the projection of the given circle FE.

Proposition XV. Problem VII.

To find the pole of a given projected circle.

Let DMF (fig. 50.) be the given projected circle, whoſe line of meaſures is DF, and C the centre of projection; from C draw the radius of projection CA, perpendicular to the line of meaſures, and A will be the projecting point: join AD, AF, and biſect the angle DAF by the ſtraight line AP; hence P is the pole. If the given projection be an hyperbola, the angle fAG (fig. 49.), biſected, will give its pole in the line of meaſures; and in a parabola, the angle fAE biſected will give its pole.

Proposition XVI. Problem VIII.

To meaſure any portion of a projected great circle, or to lay off any number of degrees thereon.

Let EP (fig. 51.) be the great circle, and IP a portion thereof to be meaſured: draw ICD perpendicular to IP; let C be the centre, and CB the radius of projection, with which deſcribe the circle EBD; make

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IA equal to IB; then A is the dividing centre of EP; hence AP being joined, the angle IAP is the measure of the arch IP.

Or, if IAP be made equal to any given angle, then IP is the correspondent arch of the projection.

Proposition XVII. Problem IX.

To measure any arch of a projected less circle, or to lay off any number of degrees on a given projected less circle.

Plate cccxxiii.

Let F *n* (fig. 52.) be the given less circle, and P its pole: from the centre of projection C draw C A, perpendicular to the line of measures GH, and equal to the radius of projection; join AP, and bisect the angle CAP by the straight line AO, to which draw AD perpendicular: describe the circle G *l* H, as far distant from the pole of projection C as the given circle is from its pole P; and through any given point *n*, in the projected circle F *n*, draw D *n l*, then H *l* is the measure of the arch F *n*.

Or let the measure be laid from H to *l*, and the line D *l* joined will cut off F *n* equal thereto.

Proposition XVIII. Problem X.

To describe the gnomonic projection of a spherical triangle, when three sides are given; and to find the measures of either of its angles.

Let ABC (fig. 53.) be a spherical triangle whose three sides are given: draw the radius CD (fig. 54.) perpendicular to the diameter of the primitive EF; and at the point D make the angles CDA, CDG, ADI, equal respectively to the sides AC, BC, AB, of the spherical triangle ABC (fig. 53.), the lines DA, DG intersecting the diameter EF, produced if necessary in the points A and G: make DI equal to DG; then from the centre C, with the radius CG, describe an arch; and from A, with the distance AI, describe another arch, intersecting the former in B; join AB, CB, and ACB will be the projection of the spherical triangle (fig. 53.); and the rectilineal angle ACB is the measure of the spherical angle ACB (fig. 53).

Proposition XIX. Problem XI.

The three angles of a spherical triangle being given, to project it, and to find the measures of the sides.

Let ABC (fig. 55.) be the spherical triangle of which the angles are given: construct another spherical triangle EFG, whose sides are the supplements of the given angles of the triangle ABC; and with the sides of this supplemental triangle describe the gnomonic projection, &c. as before.

It may be observed, that the supplemental triangle EFG has also a supplemental part EF *g*; and when the sides GE, GF, which are substituted in place of the angles A, B, are obtuse, their supplements *g* E, *g* F are to be used in the gnomonic projection of the triangle.

Proposition XX. Problem XII.

Given two sides, and the included angle of a spherical triangle, to describe the gnomonic projection of that triangle, and to find the measures of the other parts.

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Let the sides AC, CB, and the angle ACB (fig. 53.), be given: make the angles CDA, CDG (fig. 56.) equal respectively to the sides AC, CB (fig. 53.); also make the angle ACB (fig. 56.) equal to the spherical angle ACB (fig. 53.), and CB equal to CG, and ABC will be the projection of the spherical triangle.

To find the measure of the side AB: from C draw CL perpendicular to AB, and CM parallel thereto, meeting the circumference of the primitive in M; make LN equal to LM; join AN, BN, and the angle ANB will be the measure of the side AB.

To find the measure of either of the spherical angles, as BAC: from D draw DK perpendicular to AD, and make KH equal to KD: from K draw KI perpendicular to CK, and let AB produced meet KI in I, and join HI: then the rectilineal angle KHI is the measure of the spherical angle BAC. By proceeding in a similar manner, the measure of the other angle will be found.

Proposition XXI. Problem XIII.

Two angles and the intermediate side given, to describe the gnomonic projection of the triangle; and to find the measures of the remaining parts.

Let the angles CAB, ACB, and the side AC of the spherical triangle ABC (fig. 53.), be given: make the angle CDA (fig. 56.) equal to the measure of the given side AC (fig. 53.); and the angle ACB (fig. 56.) equal to the angle ACB (fig. 53.); produce AC to H, draw DK perpendicular to AD, and make KH equal to KD; draw KI perpendicular to CK, and make the angle KHI equal to the spherical angle CAB: from I, the intersection of KI, HI, to A draw IA, and let it intersect CB in B, and ACB will be the gnomonic projection of the spherical triangle ACB (fig. 53). The unknown parts of this triangle may be measured by last problem.

Proposition XXII. Problem XIV.

Two sides of a spherical triangle, and an angle opposite to one of them given, to describe the projection of the triangle; and to find the measure of the remaining parts.

Let the sides AC, CB, and the angle BAC of the spherical triangle ABC (fig. 53.) be given: make the angles CDA, CDG (fig. 56.) equal respectively to the measures of the given sides AC, BC: draw DK perpendicular to AD, make KH equal to DK, and the angle KHI equal to the given spherical angle BAC: draw the perpendicular KI, meeting HI in I; join AI; and from the centre C, with the distance CG, describe the arch GB, meeting AI in B, join CB, and ABC will be the rectilineal projection of the spherical triangle ABC (fig. 53.) and the measures of the unknown parts of the triangle may be found as before.

Proposition XXIII. Problem XV.

Given two angles, and a side opposite to one of them, to describe the gnomonic projection of the triangle, and to find the measures of the other parts.

Let the angles A, B, and the side BC of the tri-

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Plate ccccxxiii.

angle ABC (fig. 55.), be given: let the ſupplemental triangle EFE be formed, in which the angles E, F, G, are the ſupplements of the ſides BC, CA, AB reſpectively, and the ſides EF, FG, GE, the ſupplements of the angles C, A, B. Now, at the centre C (fig. 56.) make the angles CDA, CDK equal to the meaſures of the ſides GE, GF reſpectively, being the ſupplements of the angles B and A; and let the lines DA, DK interſect the diameter of the primitive EF, in the points A and K: draw DG perpendicular to AD, make GH equal to DG, and at the point H make the angle GHI equal to the angle E, or to its ſupplement; and let EI, perpendicular to CH, meet HI in I, and join AI: then from the centre C, with the diſtance CG, deſcribe an arch interſecting AI in B; join CB, and ABC will be the gnomonic projection of the given triangle ABC (fig. 55.): the ſupplement of the angle ACB (fig. 56.) is the meaſure of the ſide AB, (fig. 55.); the meaſures of the other parts are found as before.

It has already been obſerved, that this method of projection has, for the moſt part, been applied to dialling only. However, from the preceding propoſitions, it appears that all the common problems of the ſphere may be more eaſily reſolved by this than by either of the preceding methods of projection; and the facility with which theſe problems are reſolved by this method has given it the preference in dialling. It may not perhaps be amiſs, in this place, to give a brief illuſtration of it in this particular branch of ſcience.

In an horizontal dial, the centre of projection Z (fig. 57.) repreſents the zenith of the place for which the dial is to be conſtructed; ZA the perpendicular height of the ſtyle: the angle ZPA, equal to the given latitude, determines the diſtance ZP of the zenith from the pole; and AP the edge of the ſtyle, which by its ſhadow gives the hour: the angle ZAP, equal alſo to the latitude, gives the diſtance of the equator EQ from the zenith: let E *a* be equal to EA, and *a* will be the dividing point of the equator. Hence if the angles E *a* I, E *a* II, &c. E *a* XI, E *a* X, &c. be made equal to 15°, 30°, &c. the equator will be divided into hours; and lines drawn from P to theſe points of diviſion will be hour lines.

If the dial is either vertical, or inclined to the horizon, then the point Z will be the zenith of that place whoſe horizon is parallel to the plane of the dial: ZE will be the latitude of that place; and the hours on the former dial will now be changed into others, by a quantity equal to the difference of longitude between the given place and that for which the dial is to be conſtructed. Thus if it is noon when the ſhadow of the ſtyle falls on the line *P* X, then the difference of meridians is the angle E *a* X, or 30°. Hence, when a dial is to be conſtructed upon a given plane, either perpendicular or inclined to the horizon, the declination and inclination of that plane muſt be previouſly found.

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In an erect direct ſouth dial, its zenith Z is the ſouth point of the horizon, ZP is the diſtance of this point from the pole, and ZE its diſtance from the equator. If the dial is directed to the north, Z repreſents the north point of the horizon; PZ the diſtance of Z from the pole under the horizon; and ZE the elevation of the equator above the horizon.

If the dial is an erect eaſt or weſt dial, the zenith Z is the eaſt or weſt points of the horizon accordingly, and the pole P is at an infinite diſtance, for the angle ZAP is a right angle; and therefore the line AP will not meet the meridian PZ. The line ZA produced is the equator, and is divided into hours by lines perpendicular to it.

If the plane of the dial is parallel to the equator, its zenith Z coincides with one of the poles of the equator P; and hence the hour lines of this dial are formed by drawing lines from the point Z, containing angles equal to 15°.

In the preceding methods of projection of the ſphere, equal portions of a great circle on the ſphere are repreſented by unequal portions in the plane of projection, and this inequality increaſes with the diſtance from the centre of projection. Hence, in projections of the earth, thoſe places towards the circumference of the projection are very much diſtorted. In order to avoid this inconveniency, M. de la Hire * propoſed, that the eye ſhould be placed in the axis produced at the diſtance of the ſine of 45° beyond the pole: In this caſe arches of the ſphere and their projections are very nearly proportional to each other. Hence in a map of the earth agreeable to this conſtruction, the axis, inſtead of being divided into a line of ſemitangents, is divided equally, in like manner as the circumference. The map of the world, Plate CCXIV. is conſtructed agreeable to this method of projection.

* *Hiſt. de l'Academie R. des Scien.* 1701. See alſo article *Geography*, p. 650.

Projection.

PROJECTION, in perſpective, denotes the appearance, or repreſentation of an object on the perſpective plane.

The projection, *e. gr.* of a point, as B (Fig. 1. Plate CCCLXXXIII.) is a point *b*, through which the optic ray BE paſſes from the objective point through the plane to the eye; or it is the point wherein the plane cuts the optic ray.

And hence is eaſily conceived what is meant by the projection of a line, a plane, or a ſolid.

Projection in Alchemy, the caſting of a certain imaginary powder, called *powder of projection*, into a crucible, or other veſſel, full of ſome prepared metal, or other matter; which is to be hereby preſently tranſmuted into gold.

Projection, Projecture.

Powder of Projection, or of the philoſophers ſtone, is a powder ſuppoſed to have the virtue of changing any quantity of an imperfect metal, as copper or lead, into a more perfect one, as ſilver or gold, by the admixture of a little quantity thereof.

The mark to which alchemiſts direct all their endeavours, is to find the powder of projection; which every one of them has been within an ace of a hundred times. See *Philosopher's Stone.*

PROJECTURE, in architecture, the outjetting and prominency, or emboſſing, which the mouldings

Prolapſus || Prolific.

and other members have beyond the naked wall, column, &c.

PROLAPSUS, in ſurgery, a prolapſion or falling out of any part of the body from its natural ſituation: thus we ſay, *prolapſus inteſtini*, "a prolapſion of the inteſtine," &c. See SURGERY.

PROLATE, in geometry, an epithet applied to a ſpheroid produced by the revolution of a ſemi-ellipſis about its larger diameter. See SPHEROID.

PROLEGOMENA, in philology, certain preparatory obſervations or diſcourſes prefixed to a book, &c. containing ſomething neceſſary for the reader to be appriſed of, to enable him the better to underſtand the book, or to enter deeper into the ſcience, &c.

PROLEPSIS, a figure in rhetoric, by which we anticipate or prevent what might be objected by the adverſary. See ORATORY, n° 80.

PROLEPTIC, an epithet applied to a periodical diſeaſe which anticipates, or whoſe paroxyſm returns ſooner and ſooner every time; as is frequently the caſe in agues.

PROLIFER FLOS; (*proles*, "an offspring;" and *fero*, "to bear);" a prolific flower, or a flower which from its own ſubſtance produces another; a ſingular degree of luxuriance, to which full flowers are chiefly incident. See BOTANY, p. 428.

PROLIFIC, ſomething that has the qualities neceſſary for generating.

The prolific powers of ſome individuals among mankind are very extraordinary.—Inſtances have been found where children, to the number of ſix, ſeven, eight, nine, and ſometimes ſixteen, have been brought forth after one pregnancy. The wife of Emmanuel Gago, a labourer near Valladolid, was delivered, the 14th of June 1779, of five girls, the two firſt of whom were baptized: the other three were born in an hour after; two of them were baptized; but the laſt, when it came into the world, had every appearance of death. The celebrated Tarſin was brought to bed in the ſeventh month of her pregnancy, at Argenteuil near Paris, 17th July 1779, of three boys, each 14 inches and a half long, and of a girl 13 inches: they were all four baptized, but did not live 24 hours.

The public papers for the month of June 1779 made mention of one Maria Ruiz, of the diſtrict of Lucena in Andaluſia, who was ſucceſſively delivered of 16 boys, without any girls; and ſeven of them were ſtill alive on the 17th of Auguſt thereafter. The following, though a recent fact, is almoſt incredible: In the year 1755, a Muſcovite peaſant, named *James Kyrloff*, and his wife, were preſented to the Empreſs of Ruſſia. This peaſant had been twice married, and was then 70 years of age. His firſt wife was brought to bed 21 times; namely, four times of four children each time; ſeven times of three, and ten times of two; making in all 57 children, who were then alive. His ſecond wife, who accompanied him, had already been delivered ſeven times, once of three children, and ſix times of twins, which made 15 children for her ſhare. Thus the Muſcovite patriarch had already had 72 children by two marriages. We are aſſured that the ſultan Muſtapha III. had iſſue by his concubines 580 male children. What number of female children he had, and whether there were twins of both ſexes, we are not informed. Theſe facts ſuppoſe great fecundity; and whatever credit is given to them, we muſt conſider as entirely fabulous what is reported concerning a counteſs of Holland who was delivered of 365 children, of a very ſmall ſize.

Prolixity || Promiſe.

PROLIXITY, in diſcourſe, the fault of entering into too minute a detail, or being too long, preciſe, and circumſtantial, even to a degree of tedioufneſs.

PROLOCUTOR of the convocation, the ſpeaker or chairman of that aſſembly. See CONVOCATION.

PROLOGUE, in dramatic poetry, a diſcourſe addreſſed to the audience before the drama or play begins. The original intention was to advertiſe the audience of the ſubject of the piece, and to prepare them to enter more eaſily into the action, and ſometimes to make an apology for the poet.

PROMETHEUS, the ſon of Japetus, ſuppoſed to have been the firſt diſcoverer of the art of ſtriking fire by flint and ſteel; which gave riſe to the fable of his ſtealing fire from heaven: A renowned warrior; but whoſe hiſtory is involved in fable. He flouriſhed about 1687 B. C. The poetical account is, that he formed a man of clay of ſuch exquiſite workmanſhip, that Pallas, charmed with his ingenuity, offered him whatever in heaven could contribute to finiſh his deſign; and for this purpoſe took him up with her to the celeſtial manſions, where he ſtole ſome fire from the chariot of the ſun, which he uſed to animate his image. At this theft Jupiter was ſo enraged, that he ordered Vulcan to chain him down on Mount Caucaſus, and ſent an eagle or vulture to prey on his liver; which every night was renewed, in proportion to the quantity eaten up in the day-time, until at laſt he was delivered by Hercules, who killed the vulture.

PROMETHEUS, in ancient aſtronomy, was the name of a conſtellation of the northern hemiſphere, now called *Hercules*, *Engonaſin*. See ASTRONOMY, n° 406.

1 Promiſe defined.

PROMISE, in ordinary caſes, is a declaration of ſome intention to be put in execution; but in morals is a ſolemn aſſeveration by which one pledges his veracity that he ſhall perform, or cauſe to be performed, the thing which he mentions.

2 How it comes to be binding.

As ſuch a declaration excites expectations in the minds of thoſe to whom it is made; and as to fruſtrate theſe expectations might rouſe indignation, and be followed by conſequences injurious to the perſon, the character, or intereſt, of him who made it—it becomes a matter of prudence in the promiſer to keep his word. And farther, as a certain degree of confidence is found neceſſary to the very exiſtence of civil ſociety, and as others may have acted on the faith of his promiſe, it is now not a matter of prudence only to keep his word—it is a duty which he owes to all who have ſpent their time, their money, or their labour, in conſequence of thoſe expectations which he has warranted them to entertain.

It, then, being conſonant to ſound reaſon, neceſſary to the exiſtence of civil ſociety, and in general the intereſt of both the promiſer and promiſee, that the words of the promiſe ſhould be fulfilled, it has become a maxim in morals that a man is obliged to perform his promiſe.

3 Interpretation of a promiſe ſometimes difficult.

In many inſtances, the great difficulty concerning a promiſe is, how to explain it; for although the grounds of its obligation be thoſe expectations which it has raiſed, a queſtion will occur, Is the promiſer bound to anſwer

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anſwer fully all the expectations to which the different conſtructions of his words may have given birth? Should I, for inſtance, deſire a man to run with a letter to ſuch a place, and engage to ſatisfy him upon his return; and if on his return I gave him double of the uſual hire in like caſes; but if he be not ſatisfied with leſs than the triple of ſuch a ſum, am I obliged to grant his demands? This will lead us to conſider the rules by which a promiſe ſhould be interpreted.

4 Whether the meaning of the promiſer or promiſee ought to be taken.

If a promiſe were always to be deemed obligatory in the ſenſe in which the promiſee receives it, a man would not know what he had promiſed; the promiſee, from a difference of views, aſſociations, and intereſts, might conceive a ſenſe of which the promiſer had never dreamed; might ſuppoſe engagements which were never intended, which could not be foreſeen, and, although foreſeen, could not be performed. For theſe reaſons it is natural to think that the ſenſe of the promiſer ſhould rather direct the interpretation. He knows preciſely what it is he has undertaken, and is unqueſtionably the beſt judge of what meaning he affixed to his words. His explanation ſhould therefore be admitted, if information alone could give him a title to decide in the affair.

But ſomething more than mere information, or a knowledge of the cauſe, is expected from a judge, as integrity is equally eſſential to his character. Doubts may ariſe when the words will admit of various meanings, whether the promiſer will be ſo candid as impartially to own the preciſe meaning which he had actually annexed to his expreſſions: At any rate, if he wiſhed to deceive, he might purpoſely uſe an ambiguous phraſeology, and perform the promiſe in a ſenſe of his own without ſatisfying the reaſonable hopes of the promiſee.

When the daughter of Tarpeius bargained with Tatius to betray the citadel for what he and his Sabines wore on their left hands, meaning their rings and their golden bracelets, Tatius probably performed his promiſe in the way which he intended, when he cauſed her to be buried under their ſhields, which they carried alſo on their left hands. But who will ſay that here was not treachery and a diſhonourable abuſe of that confidence which had been repoſed in him?

5 In doubtful caſes the interpretation of neither is to be truſted.

It muſt therefore be obvious, that the import of a promiſe, where its meaning is diſputed, is not to be determined by the ſenſe of the promiſer nor by the expectations of the promiſee; and if it was ſaid that the obligation of a promiſe aroſe from thoſe expectations which had been raiſed by it, the aſſertion now muſt be limited to thoſe expectations which were intentionally raiſed by the promiſer, or thoſe which to his knowledge the promiſee was induced to entertain in conſequence of that declaration which had been made to him. Should there ſtill be a doubt about what expectations were intentionally raiſed, and what ſhould have been reaſonably entertained, recourſe muſt be had to the judgment of thoſe who are allowed to be perſons of candour, and who are acquainted with the characters of the men, and with thoſe circumſtances in which the promiſe was made.

6 Caſes where a promiſe is not binding.

The following are ſome of the caſes in which a promiſe is not binding. As the obligation to perform the promiſe ariſes from thoſe expectations which are intentionally raiſed by the promiſer; it is plain that no promiſe can be binding before acceptance, before the promiſe has been communicated to the promiſee, and before he has entertained hopes of its performance. The caſe is ſimilar where a promiſe is releaſed, that is, where the performance is diſpenſed with by the promiſee, and where he entertains no expectations on account of any thing that the promiſer has ſaid to him. Should a third perſon entertain hopes on account of the promiſe, he is to cheriſh theſe hopes at his own hazard, having no encouragement from the promiſer to do ſo: yet if this perſon has been warranted to hope by the promiſee, the promiſee has renounced his privilege of releaſing the promiſe, and along with the promiſer becomes bound for its performance.

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7 When it is releaſed by the promiſee.

8 Where its performance is unlawful.

A promiſe is not binding where the performance is unlawful; and the performance is unlawful where it is contrary to former promiſes, or to any moral and religious precept, which from the beginning to the end of time is of perpetual and unalterable obligation. Thus no man is bound by his promiſe to give to me what he has already promiſed to another; and no man is bound by his promiſe to blaſpheme God, to commit murder, or to criminate the innocent. Such promiſes are unlawfully made, and cannot be otherwiſe than unlawfully performed.

9 A caſe where doubts have ariſen.

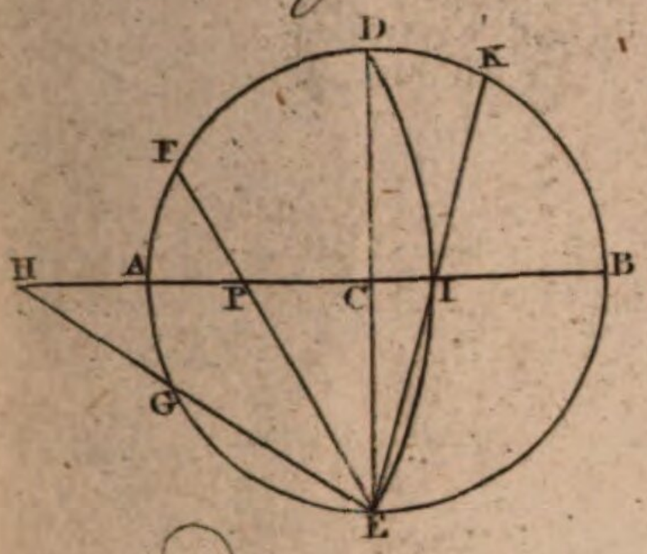
Some have even carried their ſcruples ſo far as to doubt, whether any promiſe, unlawfully made, can be lawfully performed. Should a man, during the lifetime of his wife, happen to promiſe marriage to another, ſuch a man (they ſay) by the Chriſtian religion has already committed adultery in his heart; and ſhould he afterwards become a widower, he is not bound, and he even ought not, to fulfil his engagements, as this would be putting his criminal intention into execution. This ſpecies of reaſoning, we muſt confeſs, is to us unintelligible.—As the wife is dead, what now ſhould prevent the man from marrying the object of his affections? Why, ſay the caſuiſts, he already is under a promiſe to marry her, and his promiſe was made at a time when it ſhould not have been made. It is true, the performance, conſidered by itſelf, is oppoſed by no law human or divine; but then it originated in what was wrong; and however much the Supreme Being and the bulk of the creation may be out of the ſecret, we have diſcovered by the ingenious logic of caſuiſtry, that evil can never ſpring out of good, nor good out of evil; but that the means and the end, the motive and the action are always of the ſame complexion in morals.

10 Erroneous promiſes.

When a promiſe is made, the particular circumſtances in which it is to be deemed obligatory are ſometimes mentioned. "I promiſe (for inſtance) to lend my friend 200 pounds within three days, provided a certain creditor which I name do not make a demand on me before that time. In other caſes no circumſtance is foreſeen by the promiſer to prevent the fulfilling of his engagement; and hence we have erroneous promiſes, which proceed on the ſuppoſition that things are true, poſſible, and lawful, which are not ſo. An erroneous promiſe, which proceeds on the falſe repreſentation of the promiſee, is not binding.

A London gentleman lately purchaſed an eſtate in the ſouth of England at a public ſale, believing the deſcription which he ſaw in the newſpapers, and which likewiſe was given by the auctioneer, to be true; but finding afterwards that the eſtate nowiſe correſponded to the deſcription, the law freed him from his engagement, becauſe the ſeller had evidently been guilty of

Fig. 12.



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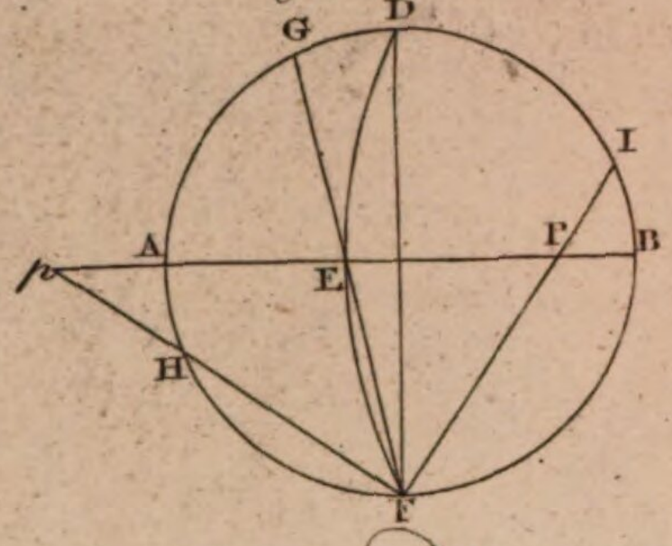

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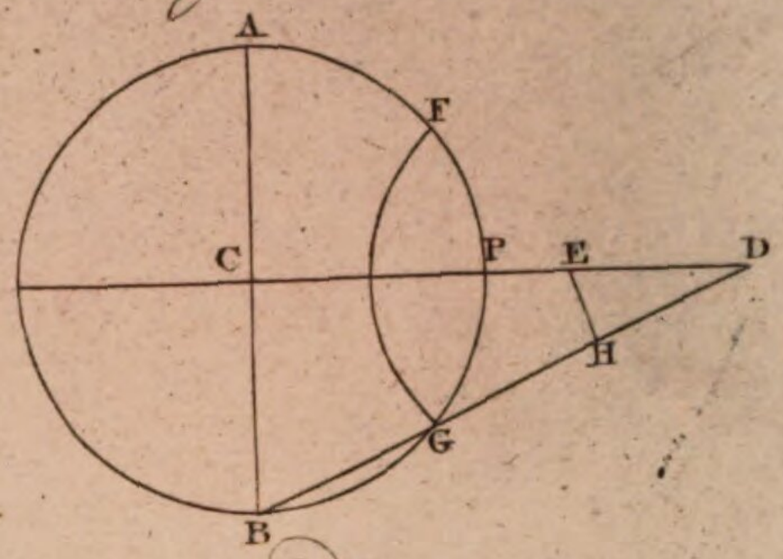

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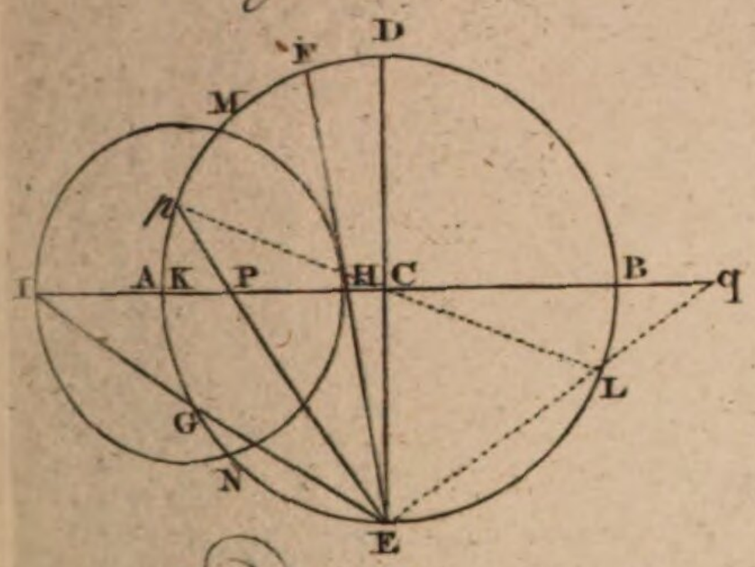

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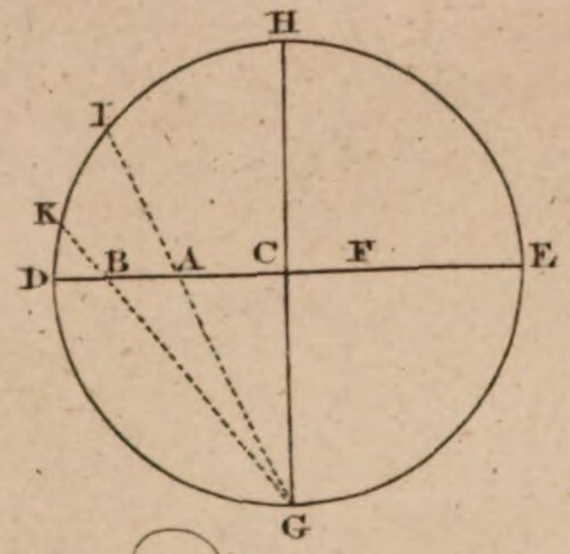

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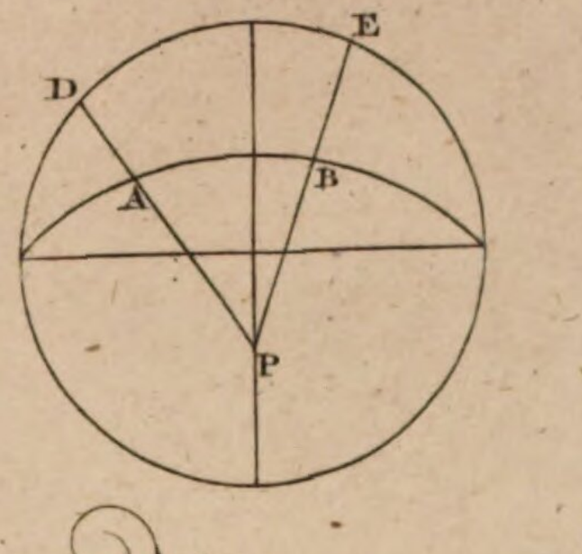

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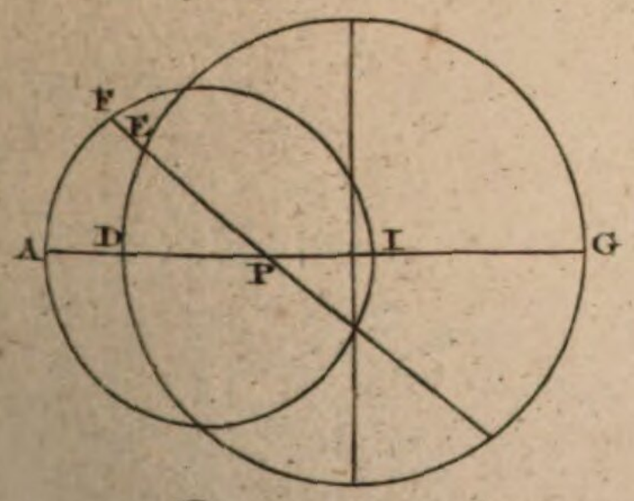

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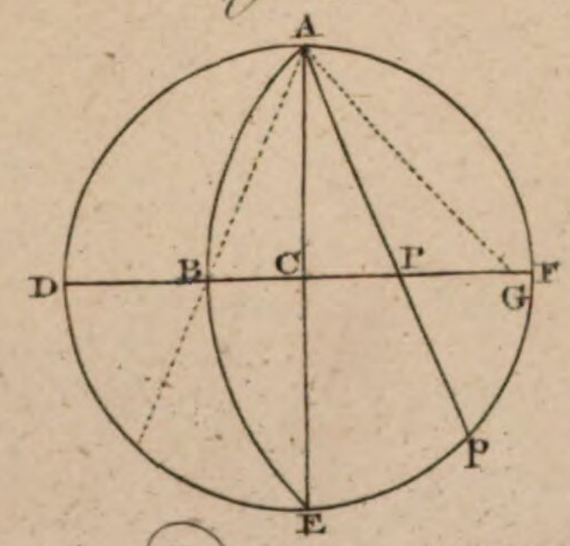

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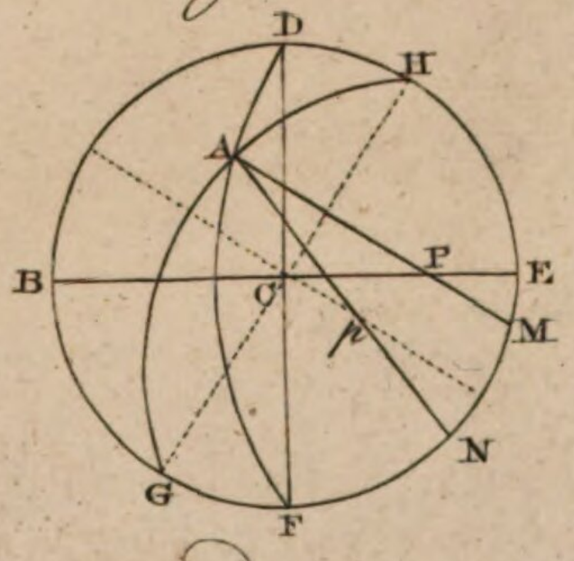

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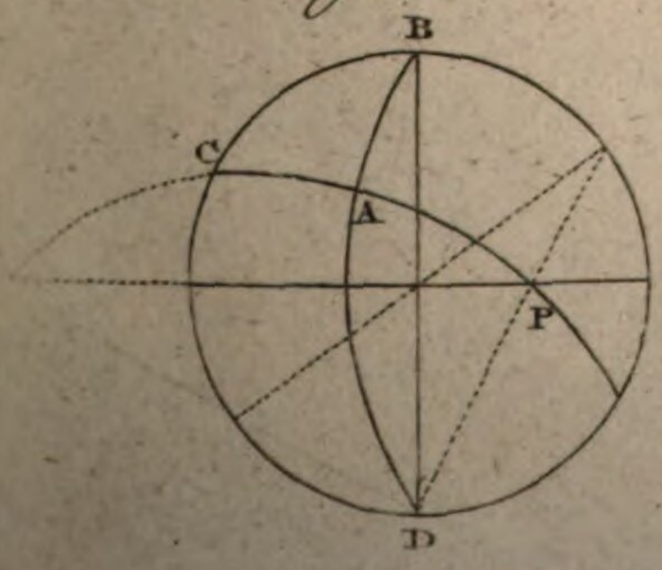

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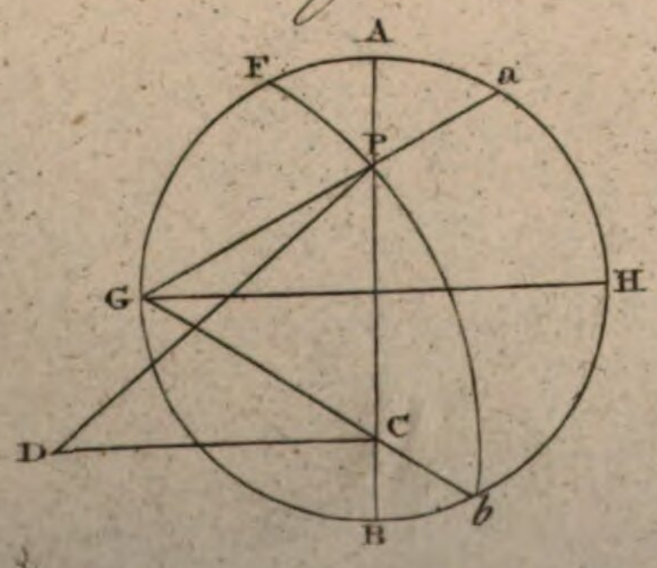

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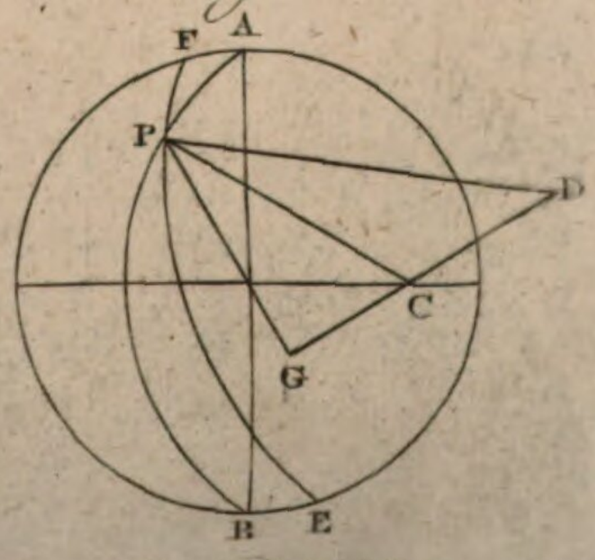

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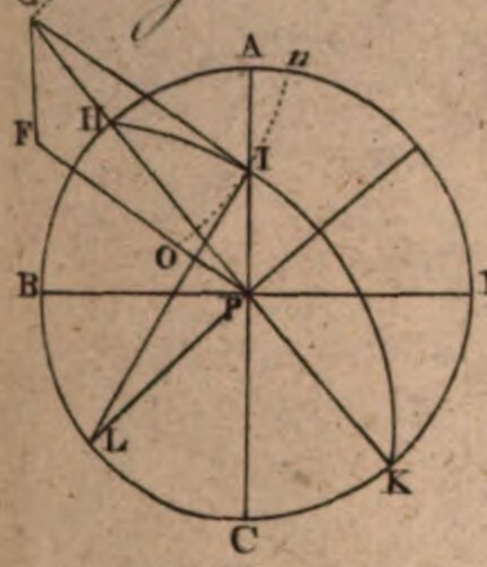
PROJECTION of the SPHERE. Plate CCCCXXI.

Fig. 24.



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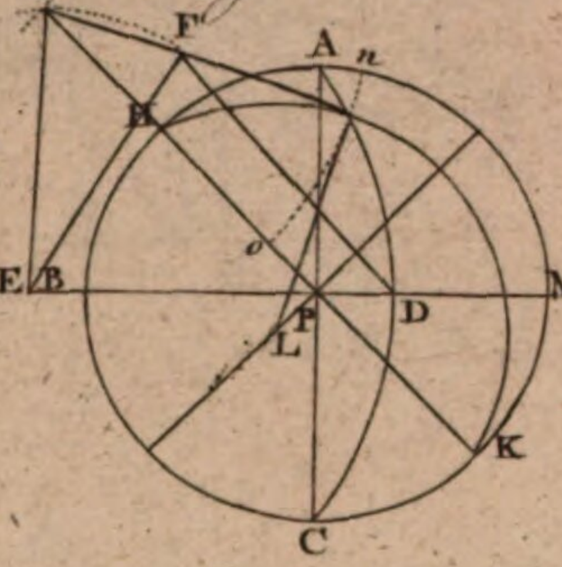

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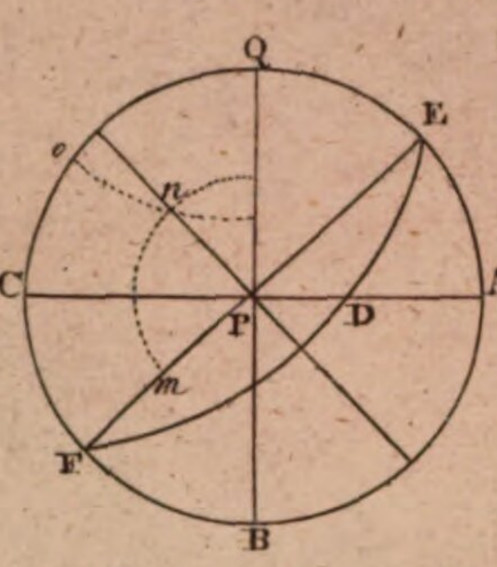

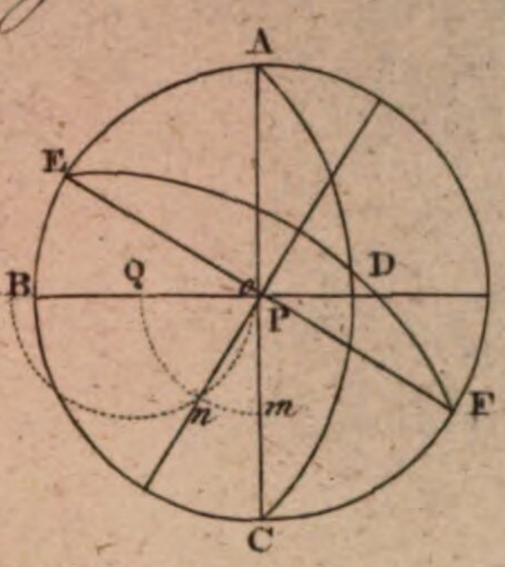

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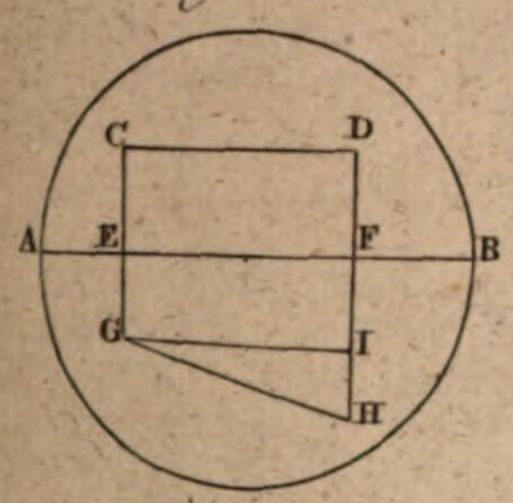

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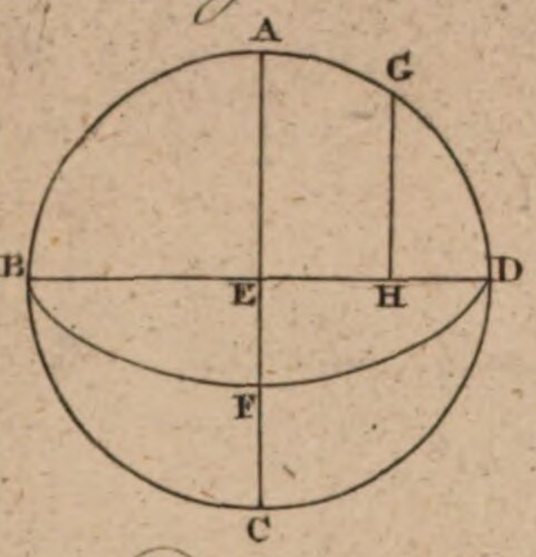

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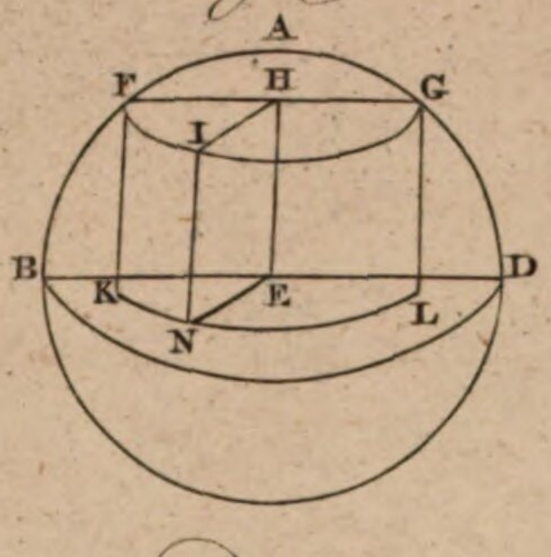

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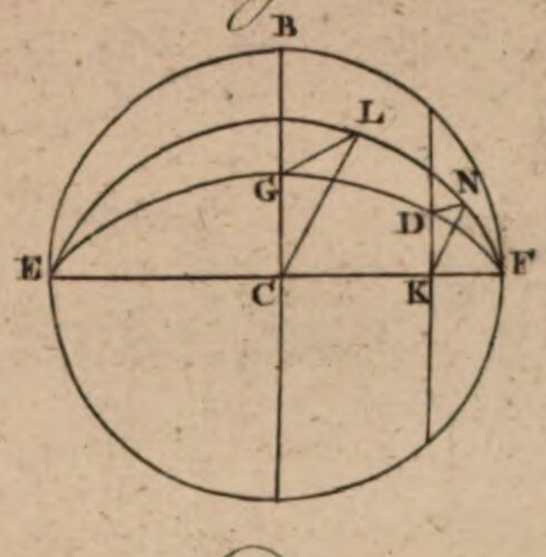

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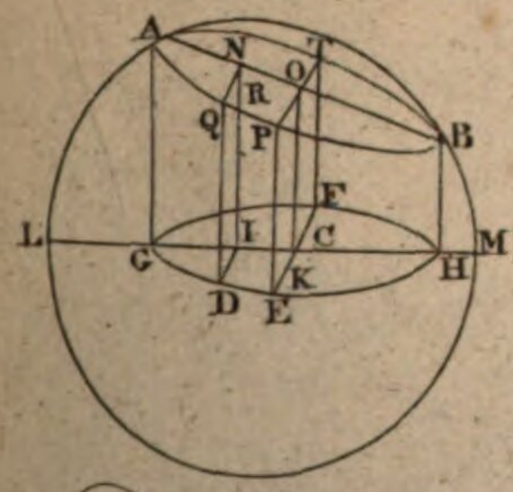

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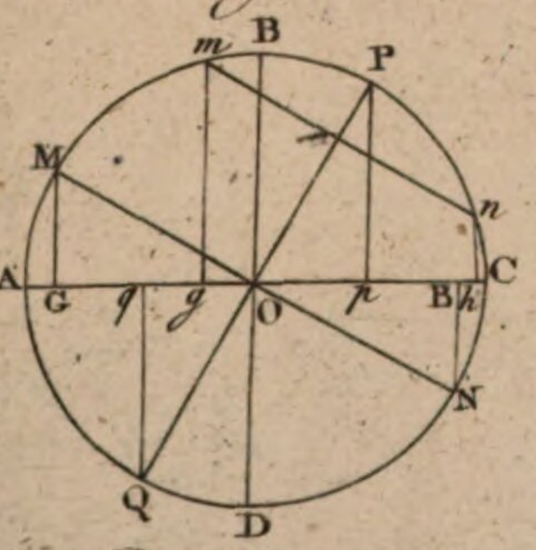

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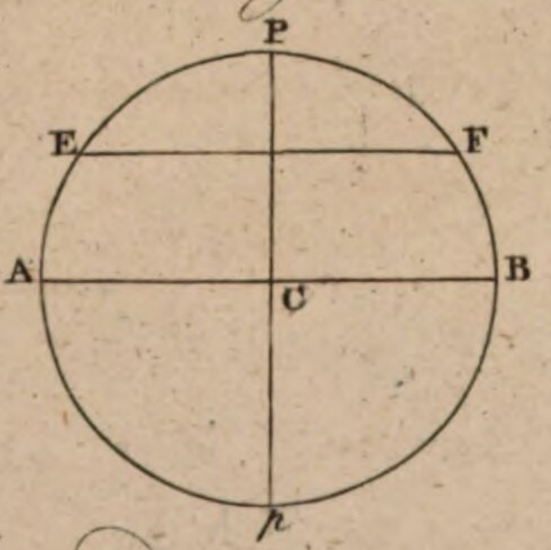

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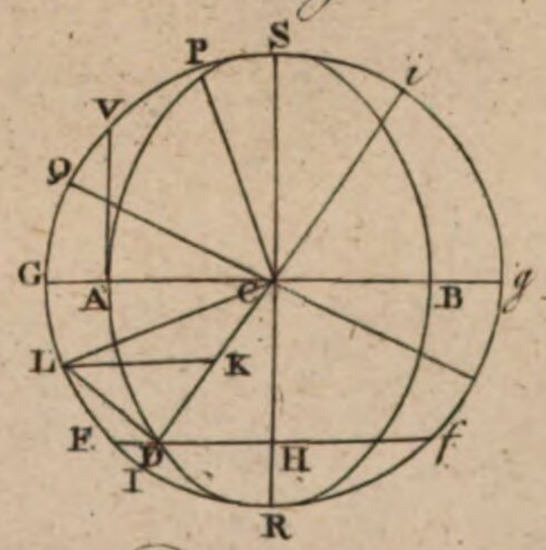

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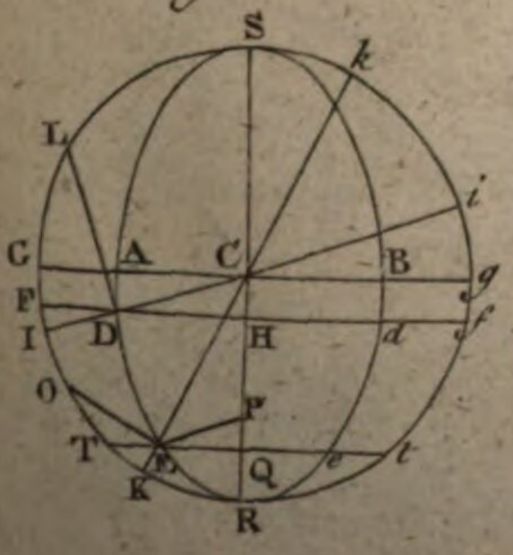

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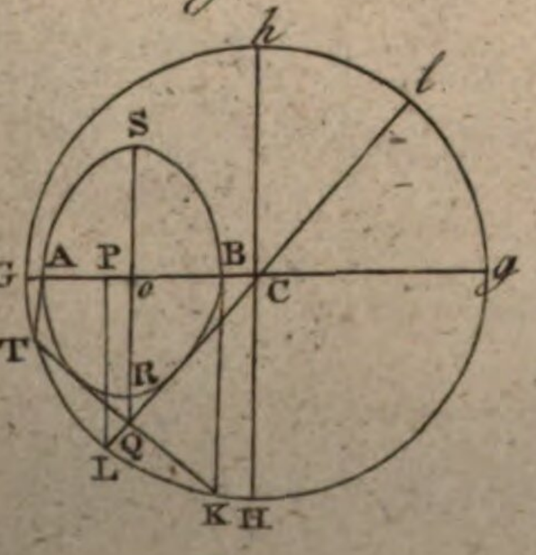
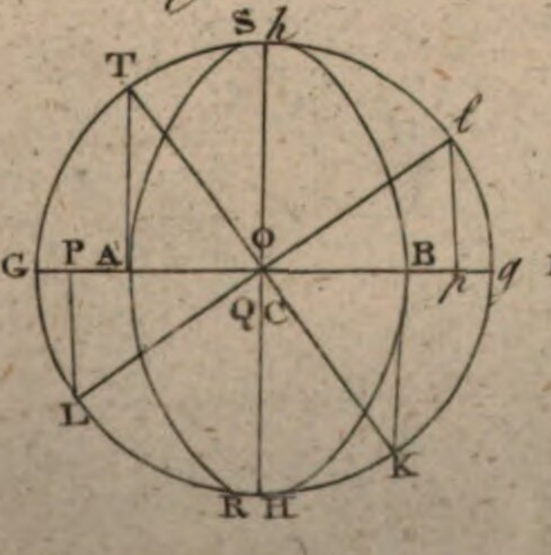


Fig. 37.



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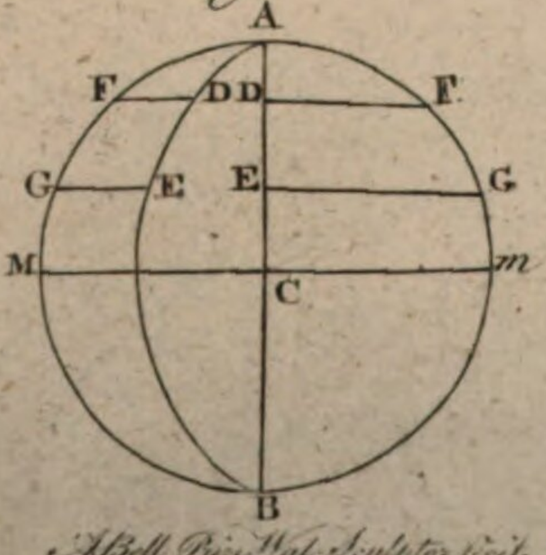

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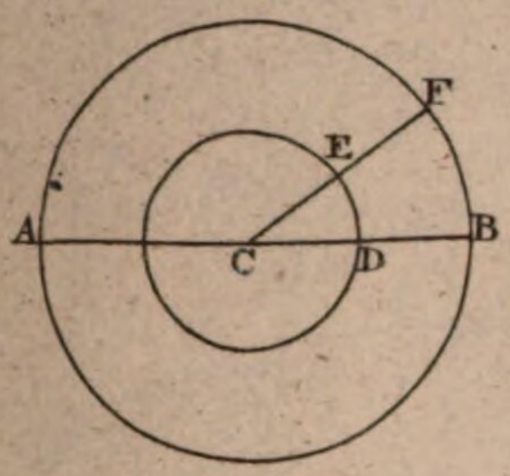
PROJECTION of the SPHERE.

Fig. 39.



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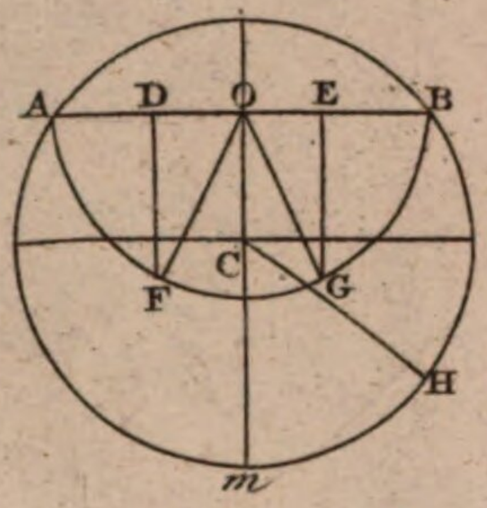

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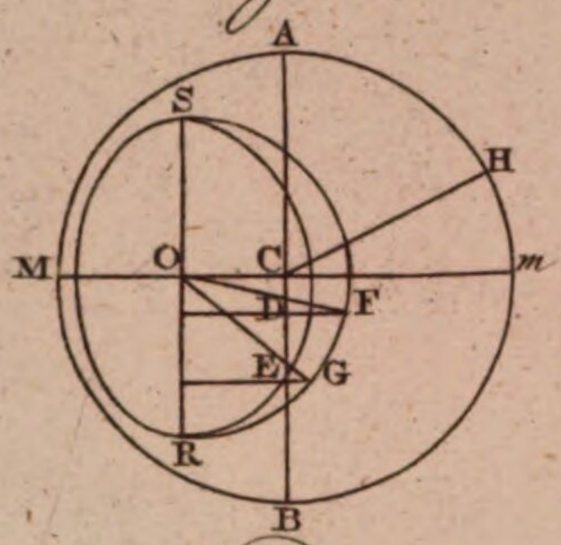

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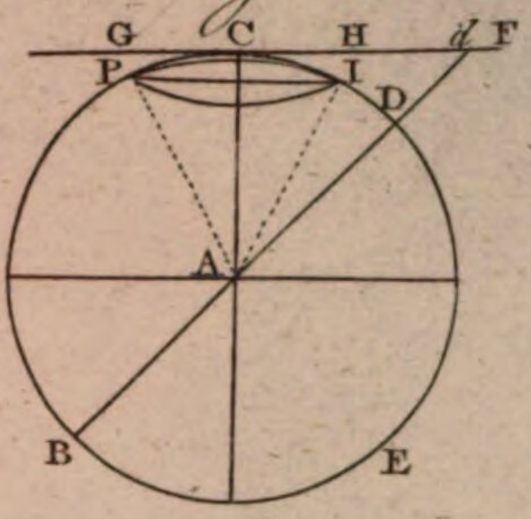

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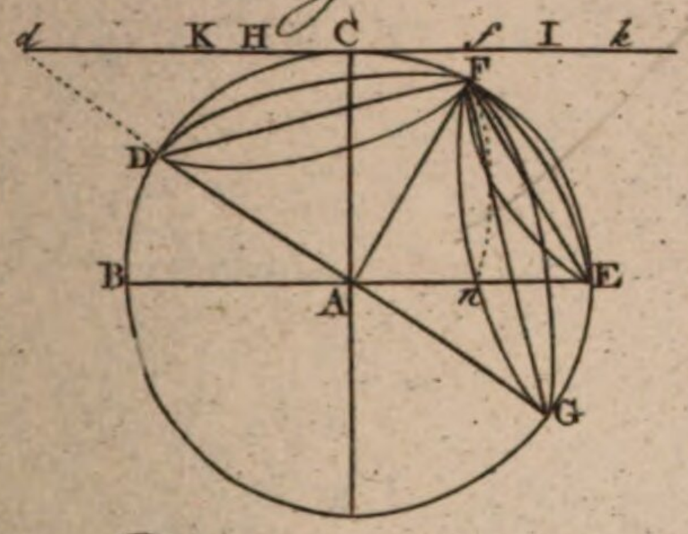

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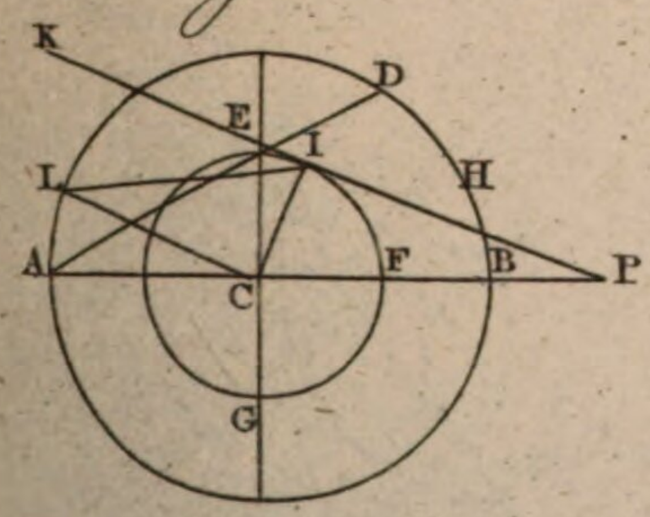
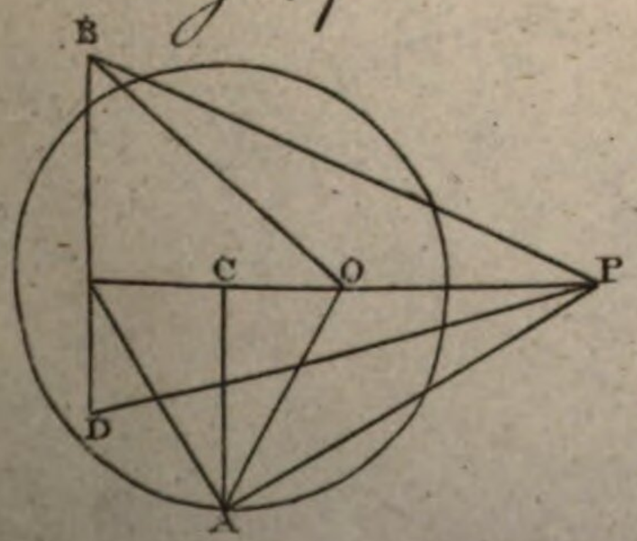


Fig. 47.



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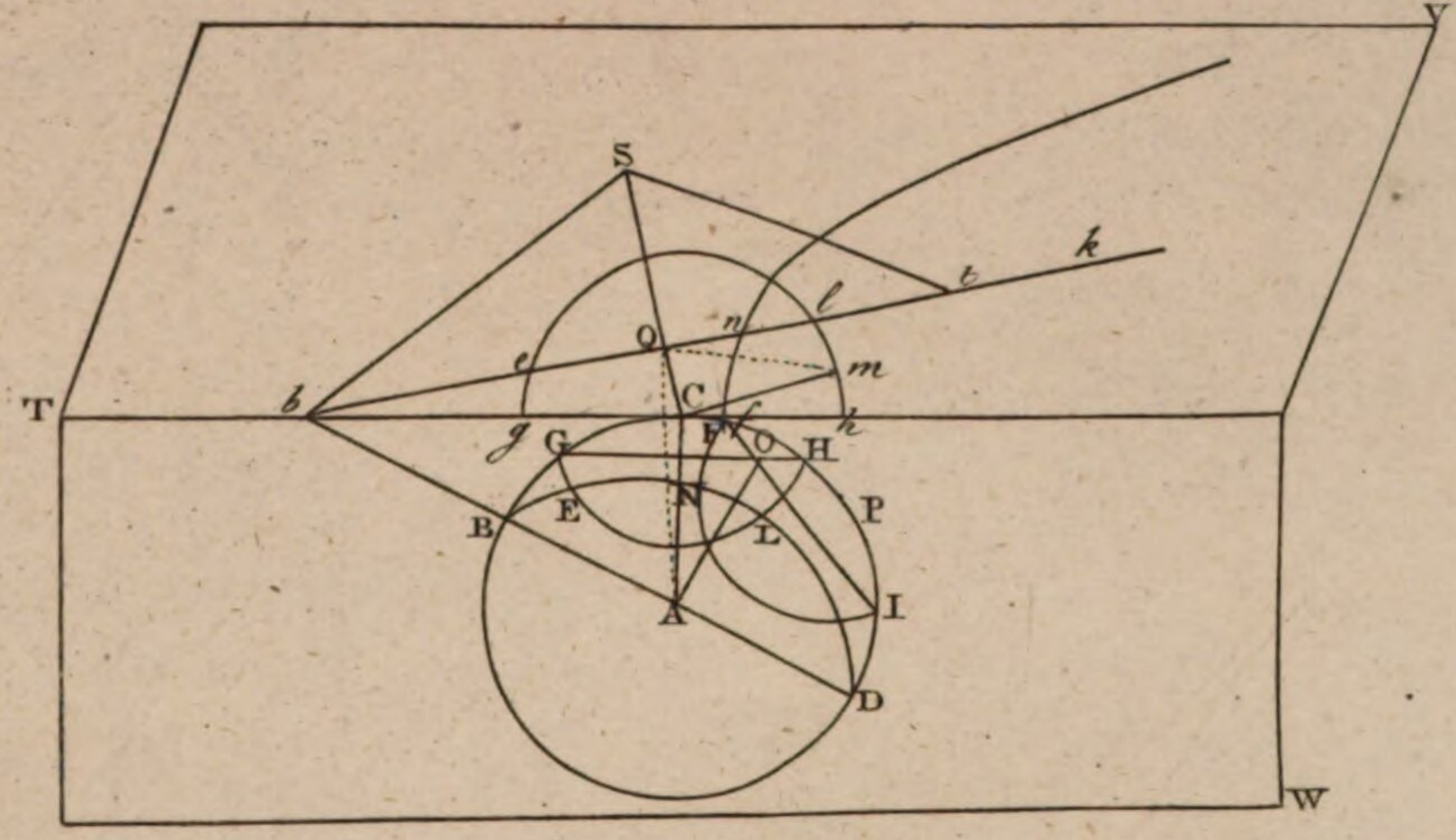
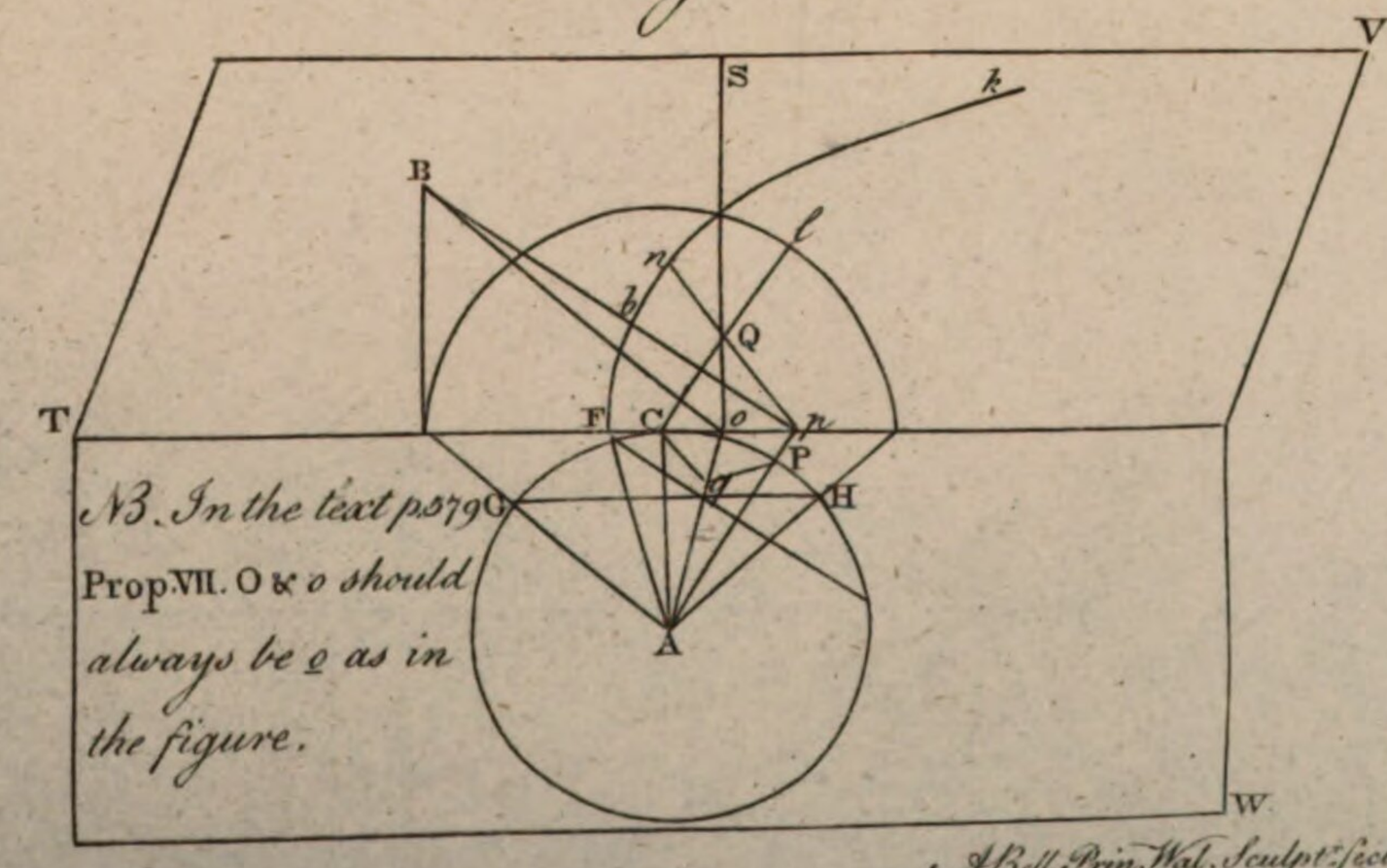


Fig. 45.



NB. In the text p. 379 Prop. VII. O & o should always be Q as in the figure.

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Fig. 48.

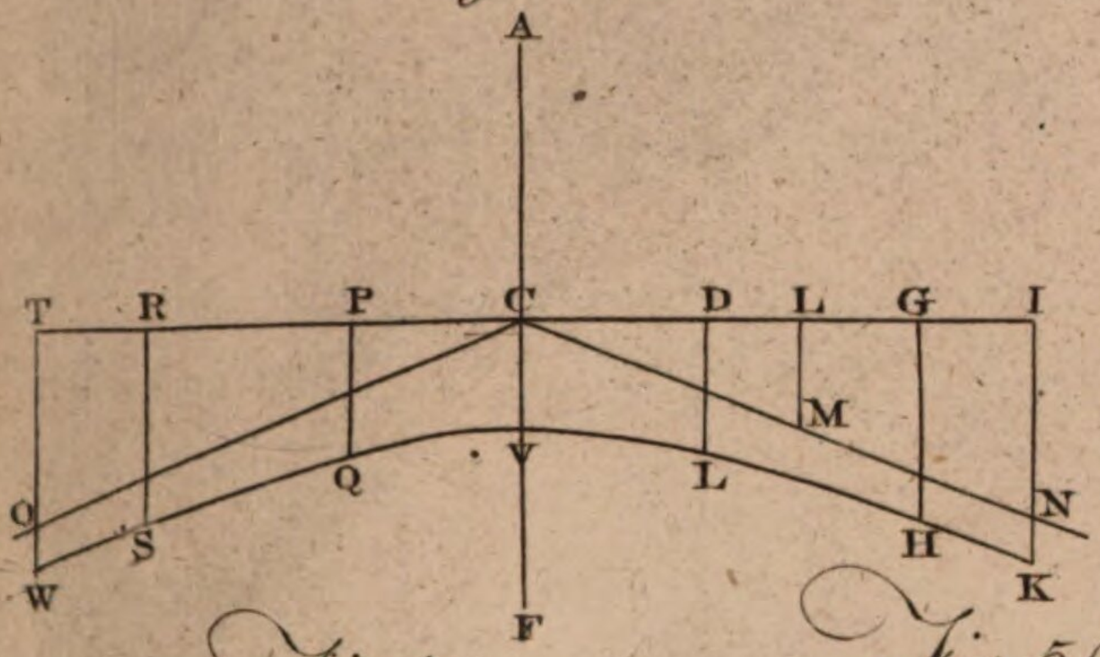
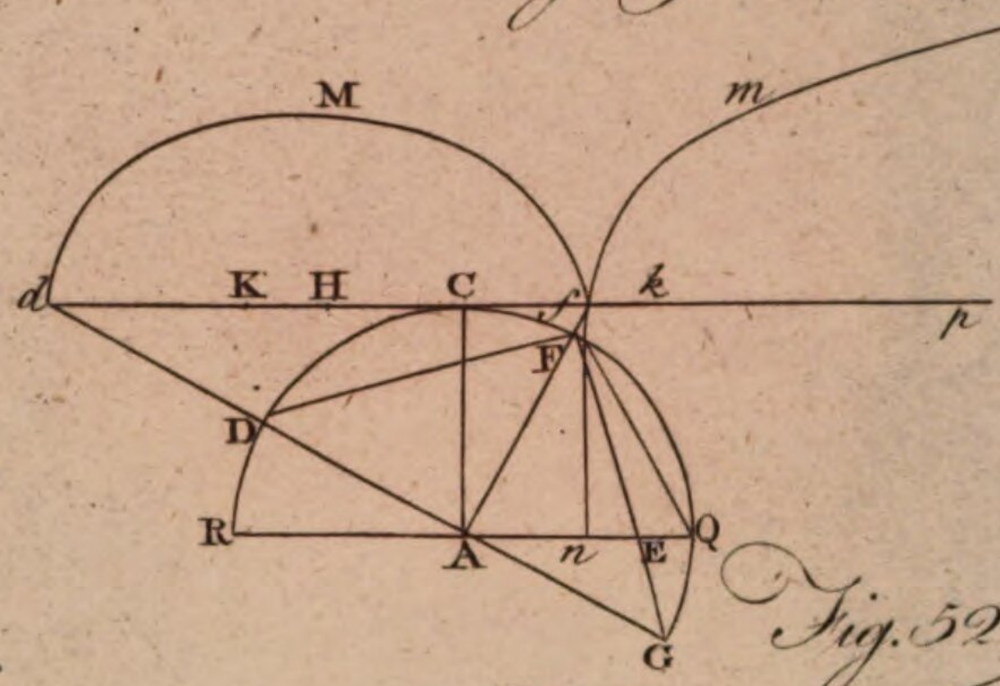


Fig. 49.



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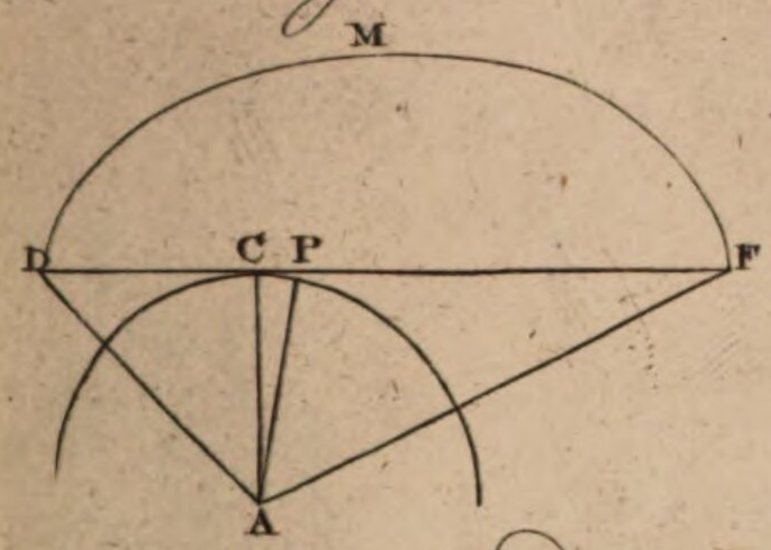

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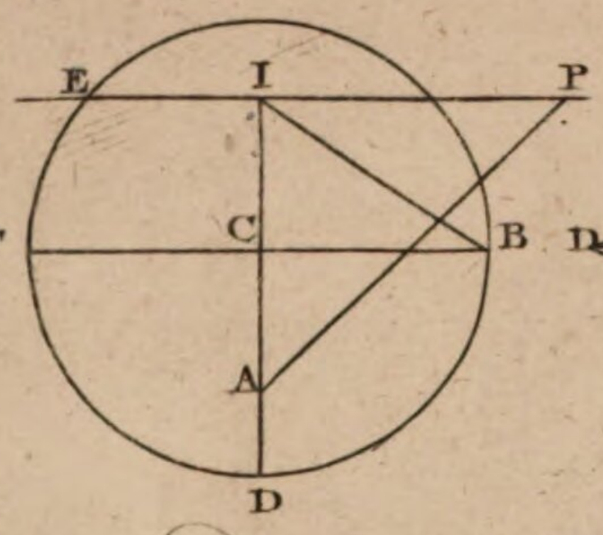

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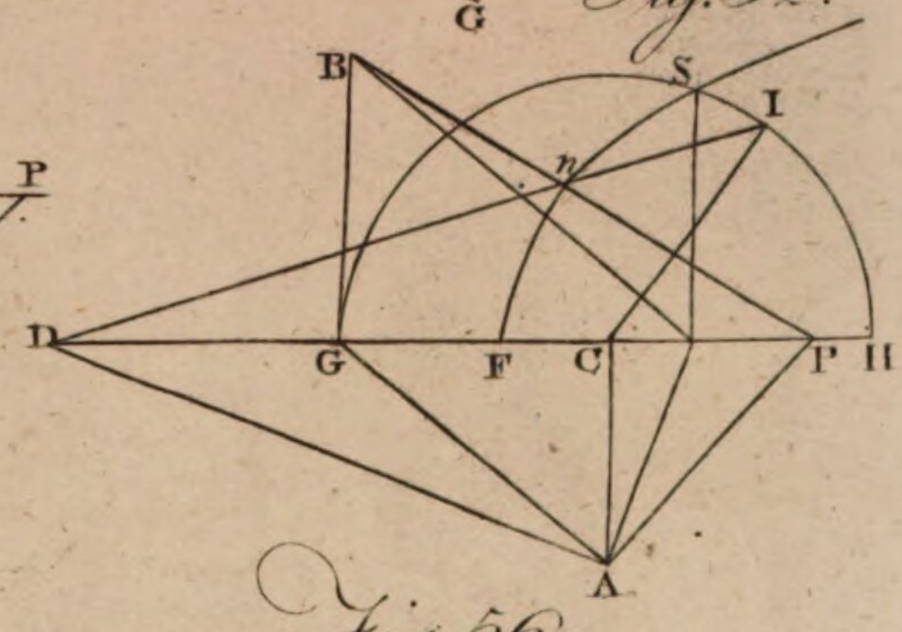
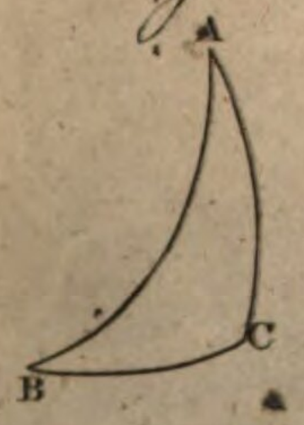


Fig. 53.



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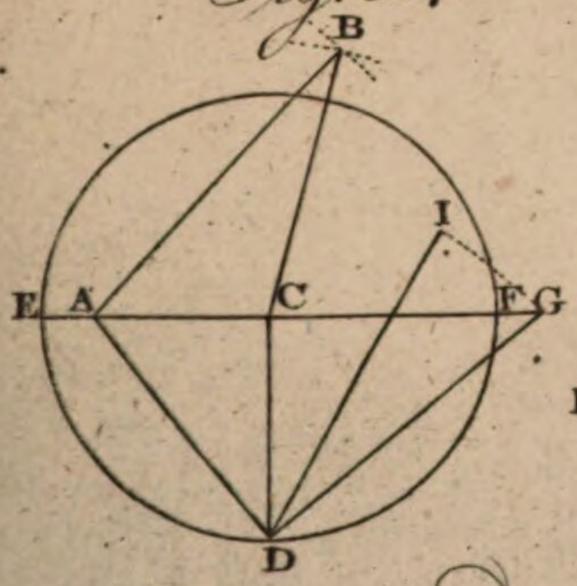

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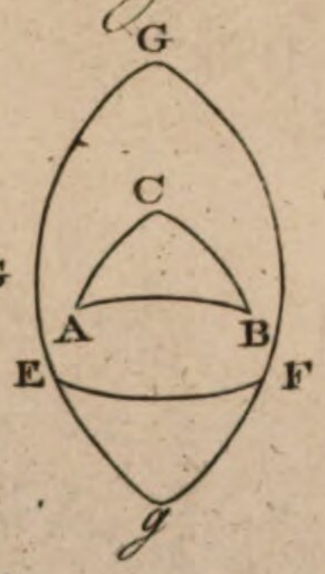


Fig. 56.

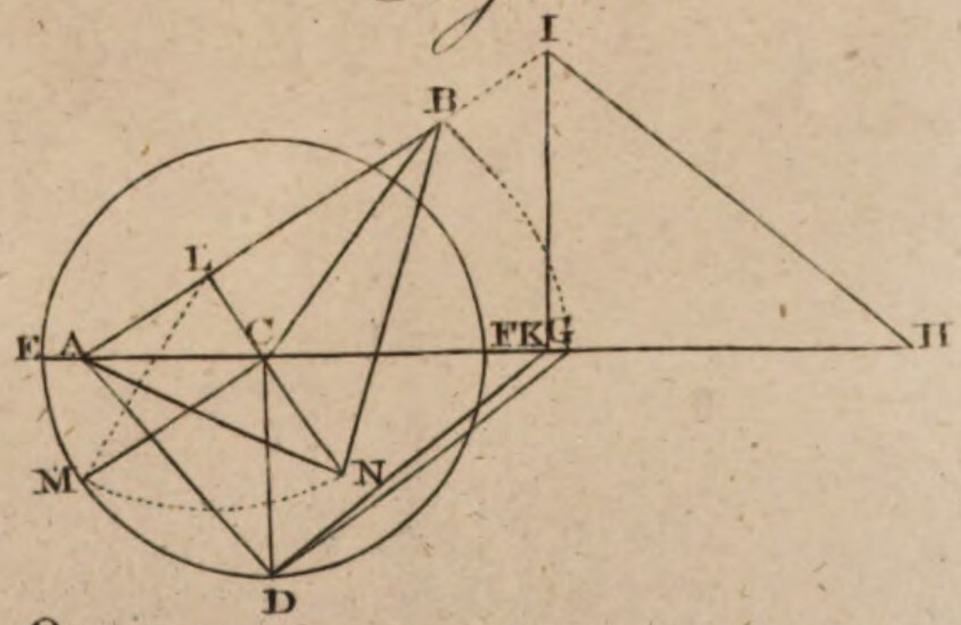
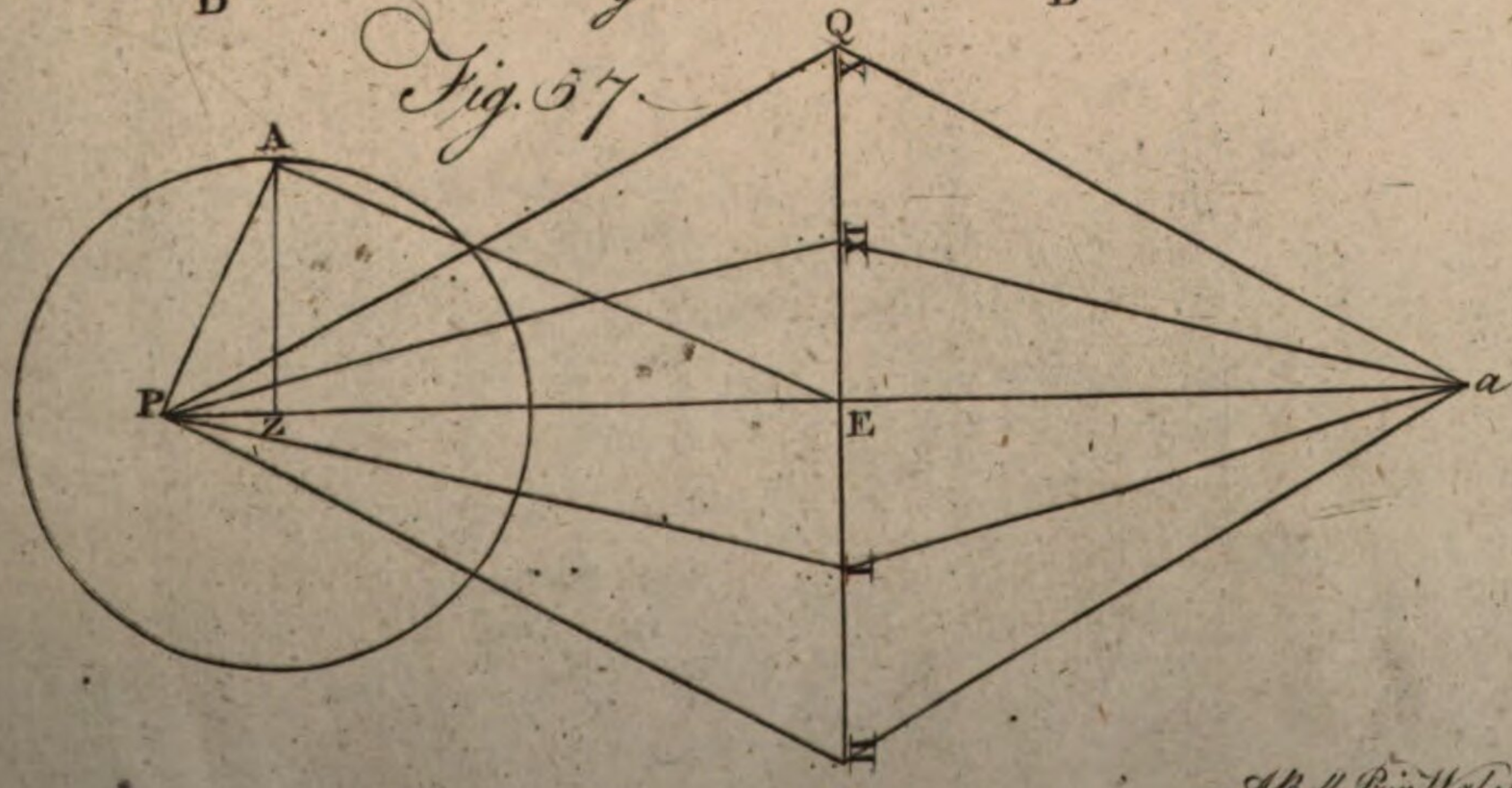


Fig. 57.



A. Bell Prin. Wal. Sculptor fecit.

Plate CCCCXXIV.

PUMP.

Fig. 1.

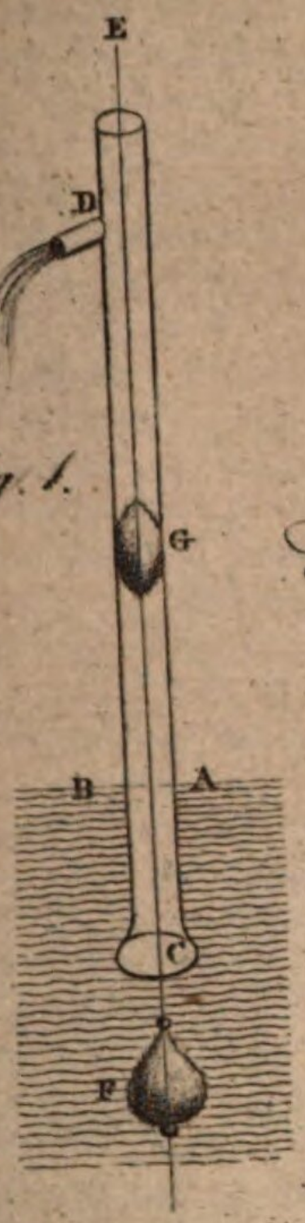


Fig. 2.

Fig. 3.

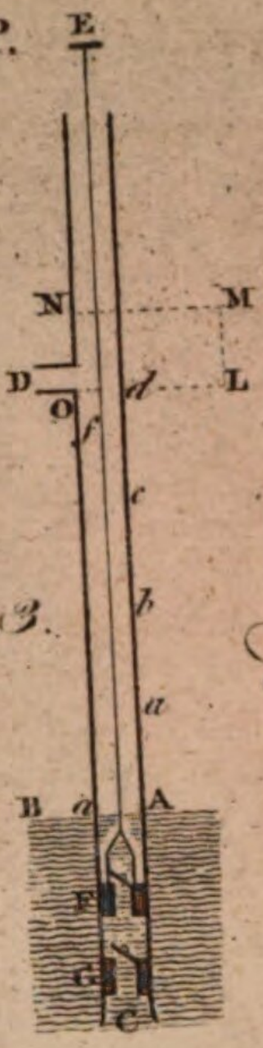


Fig. 4.

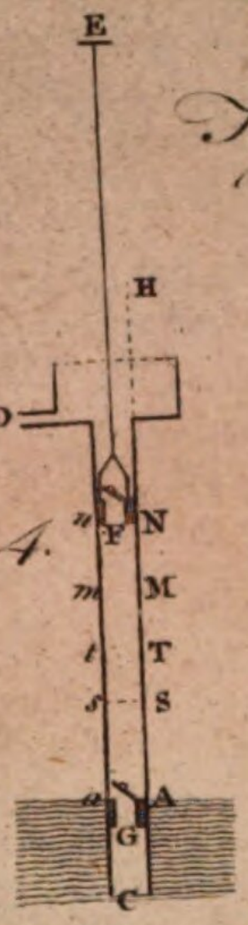


Fig. 5.

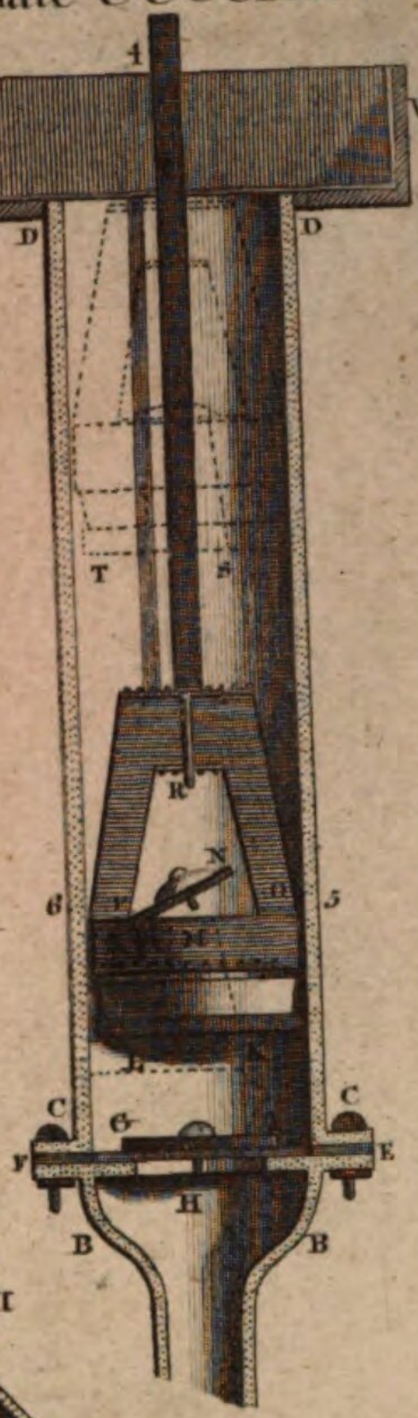


Fig. 6.

Fig. 7.

Fig. 8.

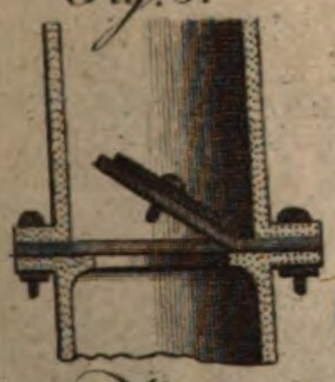


Fig. 9.

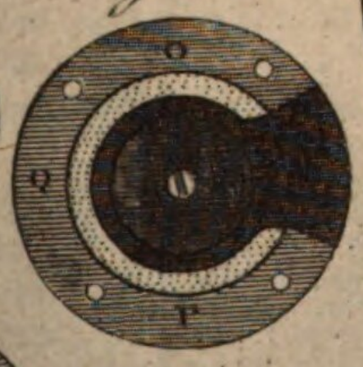


Fig. 10.

Fig. 11.

Fig. 12.

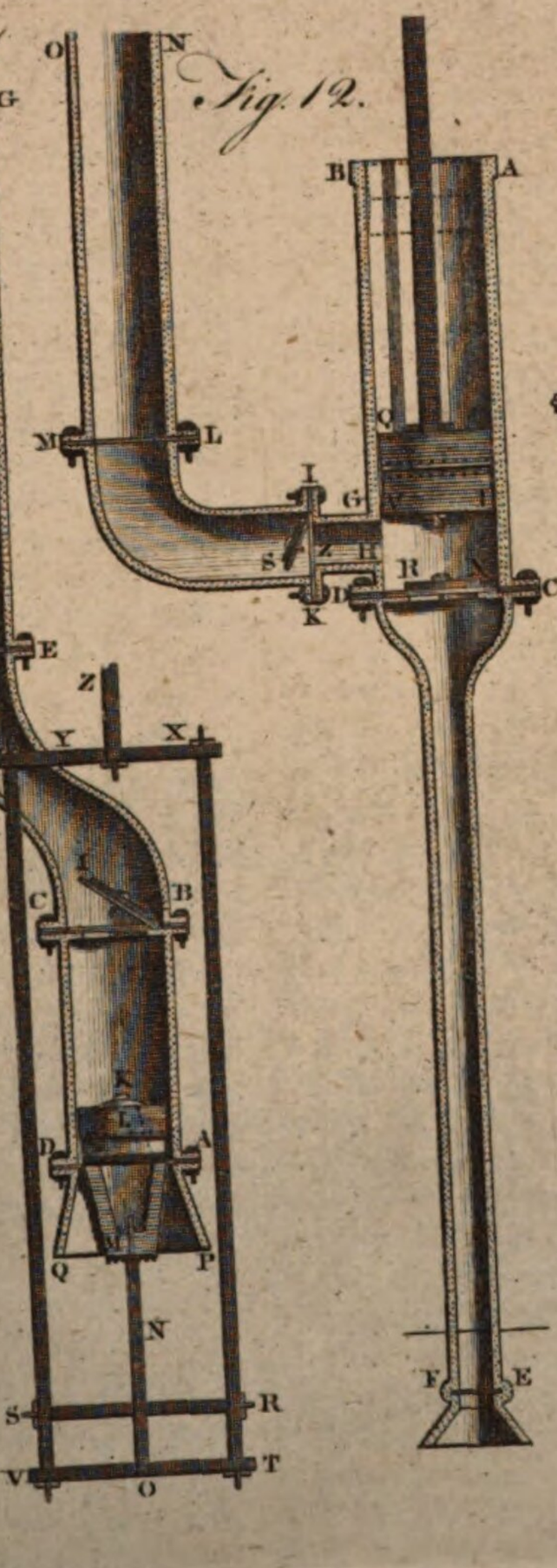


Fig. 13.

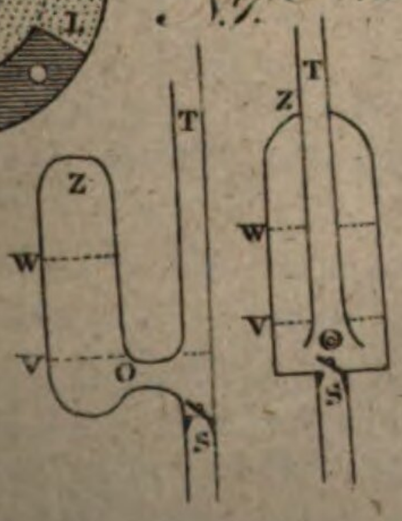


Fig. 14.

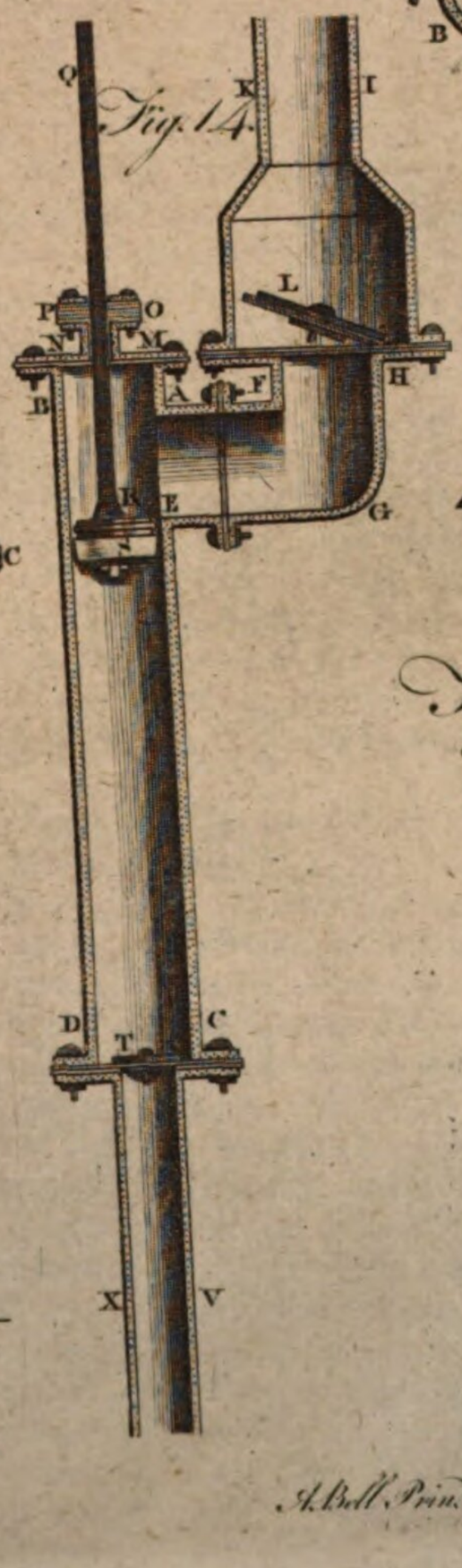
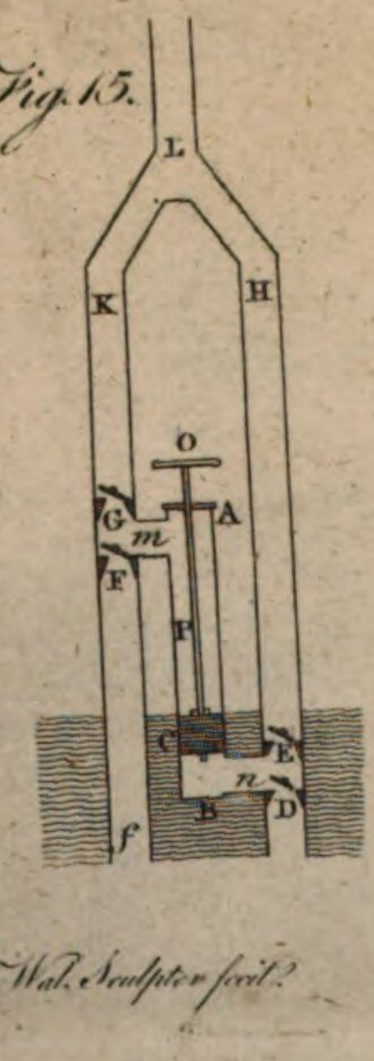


Fig. 15.



A. Bell, Prin. Wal. Sculptor fecit.

Promiſe.

a breach of promiſe in not ſatisfying thoſe expectations which he had intentionally and even ſtudiouſly excited in the buyers.

11 A promiſe not binding when the performance is impoſſible,

An erroneous promiſe, whoſe performance is impoſſible, is not binding. Before the concluſion of the late war a planter of Tobago promiſed to ſend to his friend in England 12 hogſheads of ſugar from the next year's produce of his eſtate; but before that time Tobago fell into the hands of the French, and the Weſt Indian found it impoſſible to anſwer the expectations of his friend in England.

12 Nor when it is unlawful.

An erroneous promiſe, whoſe performance is unlawful, or, to ſpeak more preciſely, whoſe performance is contrary to a prior promiſe, or to any moral or religious obligation, is not binding. A father believing the accounts from abroad of his ſon's death, ſoon after bequeathes his fortune to his nephew: but the ſon, the report of whoſe death had been falſe, returns home, and the father is releaſed from the promiſe to his nephew, becauſe it was contrary to a prior promiſe, which he had tacitly come under to his ſon. This prior promiſe was implied in the whole of the father's conduct, and was expreſſed in ſigns as emphatic and as unequivocal as thoſe of language. It had all the effect too of the moſt ſolemn promiſe on the ſon, who, to his father's knowledge, was induced in conſequence of this promiſe to entertain the moſt ſanguine hopes of ſucceeding to his father, if he ſurvived. The world likewiſe could bear teſtimony that theſe expectations were not raſhly cheriſhed. He was brought into exiſtence by means of his father, who was thereby underſtood to love him affectionately; he was uſhered into ſociety as the repreſentative of his family, and was therefore ſuppoſed to be the heir of its wealth. Religion itſelf ſupported his pretenſions, pronouncing the father worſe than an infidel who neglects to ſhow that attention to his children which the world naturally expects from a parent.—That the father's promiſe was not releaſed from the mere circumſtance that the miſtake was known to his nephew the promiſee, will appear plain from the following circumſtance. Suppoſe the father a landed proprietor, that the leaſe of one of his farms has expired, and that he has long been expecting to let it at L. 200; ſuppoſe that this ſum is refuſed, and that he agrees with the preſent tenant to grant a new leaſe at L. 150—the obligation here to perform his promiſe is not diſſolved by an after offer of L. 200, though the tenant knew that L. 200 had been expected, and that only from deſpairing of that ſum his landlord had granted the new leaſe at L. 150: the promiſe is binding, becauſe the performance is every way lawful, contrary to no prior engagement, and oppoſed to no principle in morals. The law of the land, were the proprietor reluctant, would enforce the obligation, and exact obedience in the tone of authority; becauſe breaches of faith, were they permitted in ſuch caſes, would deſtroy all confidence, and annihilate the bonds of ſocial union:

> Men live and proſper but in mutual truſt;
> A confidence of one another's truth. *Oroonoko.*

13 Utility no criterion whereby to judge of the validity of promiſes.

The great difficulty which many have to encounter in determining when erroneous promiſes ought or ought not to be kept, ariſes from their proceeding on a principle of whoſe conſequences they do not ſeem to be always aware. There is ſeldom, they perceive, a virtuous action that is not attended with ſome happy effects; and it will, perhaps, be generally allowed, that the comparative merit of ſimilar virtues may ſafely be eſtimated by their utility: But to make utility, as ſome do, the criterion of virtue, and pronounce an action vicious or virtuous merely on account of thoſe conſequences which they ſee may flow from it, is a dangerous maxim. Evil has often ſprung out of good, and good out of evil; and good and evil have frequently ſprung from the ſame action. In Mandeville's *Hive*,

14 This principle would give a ſanction to vice and falſehood.

> That root of evil Avarice,
> That damn'd ill-natur'd baneful vice,
> Was ſlave to Prodigality,
> That noble ſin; whilſt Luxury
> Employ'd a million of the poor,
> And odious Pride a million more.
> Envy itſelf and Vanity
> Were miniſters of Induſtry:
> That darling folly, Fickleneſs,
> In diet, furniture, and dreſs,
> That ſtrange ridiculous vice, was made
> The very wheel that turn'd the trade.

The deſcription here is not altogether falſe; and theſe indeed may be ſome of the conſequences that flow from avarice, luxury, pride, vanity, and envy: but theſe are not all.—To ſee at once all the conſequences that ſpring from an action, the good and the bad, the particular and general, the immediate and remote, would require ſometimes the foreſight of Omniſcience, and at all times a knowledge ſuperior to what is human. In the Fable of the Bees, the author's object was to ſhow that private vices are public benefits; and he therefore was naturally led by his argument to conſider only ſuch conſequences of vice as favoured his hypotheſis. He wanted candour. And that artifice which runs through his Fable happens to remind us, that while the remote and the general effects of an action may not be ſeen, the particular and immediate, which fall within our notice, are apt to be viewed through the medium of paſſion, intereſt, or opinion. For theſe reaſons, it appears ſurpriſing how any perſon ſhould ever imagine that the obligation to perform a promiſe ſhould depend entirely upon the ideas which the promiſer apprehended of its utility.

The beſt refutation of ſuch an opinion are the ſingular concluſions to which it leads.

15 The conſequences that flow from it ridiculous and abſurd.

A late writer on political juſtice, who appears to have embraced it, gets into reaſoning not very common. In a part of his ſyſtem he looks on morals as an article of trade: virtue and vice, in his Chapter of *Promiſes*, are but antiquated terms for profit and loſs; and right and wrong are uſed to expreſs what is beneficial and what is hurtful, in his apprehenſion, to himſelf and the community.—With reſpect to veracity, thoſe "rational and intelligent beings," by whom he wiſhes the affairs of the world to be carried on, may, while they act as rational and intelligent, break or perform their promiſes at pleaſure. He thinks it "eſſential to various circumſtances of human intercourſe, that we ſhould be known to beſtow a ſteady attention upon the quantities of convenience or inconvenience, of good or evil, that might ariſe to others from our conduct." After this attention, the diſappointment of the promiſee is not to be

Promiſe. minded, though the expectations excited by theſe "rational and intelligent beings" may have "altered the nature of his ſituation, and engaged him in undertakings from which he would otherwiſe have abſtained." What the promiſer takes to be the general utility and the fitneſs of things is to be his guide. And a breach of promiſe will be attended with the following advantages: "The promiſee, and all other men, will be taught to depend more upon their own exertions, and leſs upon the aſſiſtance of others, which caprice may refuſe or juſtice with-hold. He and all others will be taught to acquire ſuch merit, and to engage in ſuch purſuits, as ſhall oblige any honeſt man to come to their ſuccour if they ſhould ſtand in need of aſſiſtance." This breach of promiſe, with a view to the general utility, will, ſo far from being criminal, form a part of that reſolute execution of juſtice which would in a thouſand ways increaſe the independence, the energies, and the virtue of mankind*."

* *Godwin's Inquiry concerning Political Juſtice*, book 3. ch. 3.

Such are the views which determined this author to conſider "the validity of promiſes" as "inconſiſtent with juſtice," and as "foreign to general good." From one, however, who relies with ſo much confidence on the promiſer, it would be certainly deſirable to know, whether the perſon, who violates his faith for the public utility, is always to be candid. Where breach of faith promotes his own intereſt, ought he alone to decide on the validity of his promiſe? or where promiſes are broken for the general good, is he to be guided by his own viſionary ſchemes of utility? Is he to act as truſtee for the public without any delegated power? and ſhall the community ſubmit to his deciſions without ſo much as putting the queſtion, Who hath made thee a ruler overs us? When a writer thus deviates ſo far from the path of reaſon, it is natural to aſk, what was the *ignis fatuus* that miſled him? In the preſent caſe it is pretty obvious. Being ſomething of opinion with the celebrated Turgot*, that romances are the only books in which moral principles are treated in an impartial manner, this gentleman, in his Chapter of *Promiſes*, ſeems to have borrowed a part of his morality from the doggerels of Butler; and having adopted, though from different motives, the political principles of Sir Hudibras's ſquire, that obedience to civil government is not due becauſe it is promiſed, he has come to exactly the ſame concluſion with reſpect to the obligation of keeping one's word. But Ralph has reaſoned with more ingenuity; and has ſhown not only that the public good, but the glory of the Lord, may be ſometimes promoted by a breach of faith.

16 A private individual has no right to intrude his ſchemes of utility on the public

* See Note, b. iii. ch. 6.

* The ſaints are Godwin's rational and intelligent beings.

The ſaints, * whom oaths and vows oblige,
Know little of their privilege;
Farther, I mean, than carrying on
Some ſelf-advantage of their own:
For if the dev'l, to ſerve his turn,
Can tell truth, why the ſaints ſhould ſcorn,
When it ſerves theirs, to ſwear and lie,
I think there's little reaſon why:
Elſe h' has a greater pow'r than they,
Which 'twere impiety to ſay:
W' are not commanded to forbear,
Indefinitely, at all to ſwear;
But to ſwear idly, and in vain,
Without ſelf-intereſt and gain;
For breaking of an oath and lying
Is but a kind of ſelf-denying,
A ſaint-like virtue; and from hence
Some have broke oaths by Providence:
Some, to the glory of the Lord,
Perjur'd themſelves and broke their word:——
For ſaints may do the ſame thing by
The ſpirit, in ſincerity,
Which other men are tempted to,
And at the devil's inſtance do.

HUDIBRAS, *Cant.* II.

Promiſe.

Here are new views of utility; which, were they to be conſidered as of any weight, would increaſe the difficulty of determining when an erroneous promiſe ought to be kept.

But ſhould views of utility be laid aſide, and ſhould it be made an invariable rule that truth is on no account to be violated, that deceit is never to be practiſed, and that moral obligations are not to be diſſolved for the proſpect of any phyſical advantage; thoſe doubts which ariſe concerning the validity of erroneous promiſes will ſoon diſappear. Diſagreeable perhaps and ridiculous conſequences may ſometimes ariſe to a few individuals from an honeſt and conſcientious adherence to their promiſe; but will any aſſert that the general good, *that burden of the ſong*, will ever be endangered by too much veracity?

17 Views of utility an unſafe guide in morals.

So numerous inconveniences ariſe daily from the regular operation of thoſe great phyſical laws, which are under the immediate direction of Providence, that thoſe philoſophers who have adopted the principle of utility, and are much ſurpriſed to ſee the univerſe ſo aukwardly planned for the eaſe and comfort of them and their ſpecies, have been under the neceſſity of imputing many events in nature to the malignity of ſome evil independent being; or of allowing that things have degenerated ſince they firſt came from the hands of the Creator, and that they muſt now be exceedingly altered from what they had been when He choſe to pronounce them all very good. Thus, abſurdity or impiety muſt always be the conſequence of judging of the vice and virtue of an action by its utility, and of eſtimating its utility by our limited views and erroneous conceptions.

As for extorted promiſes, it is curious to obſerve how this queſtion ſhould always be ſtarted, whether or not they ought to be kept? and another queſtion ſhould ſeldom be thought of, whether or not they ought to be made? Fortitude was one of the cardinal virtues among the ancients; and is deemed of ſuch importance in the Chriſtian ſyſtem, that the fearful are claſſed with the unbelievers, and are thought unworthy of the favour of Deity, as being incapable of ſupporting thoſe trials to which heaven expoſes the faithful as the trueſt teſt of Chriſtian virtue.—If a perſon ſhould want the neceſſary fortitude to be virtuous, it will be a poor excuſe for his baſeneſs, that he has added deceit to his cowardice: and ſurely it is not the buſineſs of morality, when it has found him guilty of one crime, to grant him a diſpenſation for committing two. The laws of juriſprudence, it will readily be allowed, cannot favour the claims of the promiſee; becauſe they ought never to

18 Extorted promiſes,

19 Whether binding or not.

Promiſe. to lend their ſupport to oppreſſion and violence. But their acquittal, ſhould he violate his faith, will by no means vindicate the character of the promiſer. Their acquitting a woman from the charge of adultery, goes a ſhort way in reſtoring the fair reputation of her innocence.

Let juriſprudence decide as it will, the man of honour and the generous patriot can never be brought to reſpect the perſon who, ſtruck with a panic, could betray either himſelf or his friends. The magnanimous ſpirits who could die for the truth will view with contempt his pitiful deceit. Thoſe unfortunate men who may ſuffer from that very diſtruſt which the breach of his faith has begotten, will always deteſt him as a traitor and enemy; and heaven itſelf cannot be ſuppoſed to reward that ſoldier who deſerts her cauſe, and relinquiſhes the poſt which ſhe has aſſigned him, at the ſight of danger.

If we once begin to accommodate morality to the diſpoſitions and humours of mankind, it is hard to ſay where this ſpecies of complaiſance will end. The degrees of timidity are ſo various, and ſome tempers by nature ſo yielding, that repeated importunity or an earneſt requeſt will extort a promiſe.

20 The laws of morality are not to be accomodated to the humours and intereſts of mankind.

A young lady was frequently preſſed by her dying huſband to grant him a promiſe that ſhe would not marry after his death. For ſome time ſhe was able to reſiſt with becoming ſpirit his abſurd requeſt; but upon his declaring oftener than once that he could not otherwiſe die in peace, ſhe complied and promiſed. Too young, however, for this effort of continence, ſhe afterwards liſtened to the addreſſes of a ſecond lover, and found her heart inſenſibly engaged before ſhe adverted to the impropriety of a new attachment. But propoſals of marriage could ſcarcely fail to remind her of her promiſe and awaken her ſcruples. Theſe ſhe ſoon communicated to her lover, with her firm reſolution to remain a widow, if the contrary meaſure, which ſhe greatly preferred, and on which her earthly happineſs depended, were not approved by ſome ſpiritual counſellor.

Upon this declaration it was agreed to take the advice of their own miniſter, who was an eminent diſſenting clergyman in the dioceſe of Oxford: but this gentleman, unwilling to decide in a matter of ſuch importance, propoſed to refer it to Dr Secker, who was then biſhop of that ſee. This prelate too declined to give any judgment in the caſe; but, as was his way, muſtered up a number of arguments on each ſide of the queſtion, and committed them to a letter, which a learned gentleman of our acquaintance had ſome time ago an opportunity of ſeeing in manuſcript.

If the ſentiments to which the biſhop was inclined could have been inferred from his ſtatement of arguments, he ſeemed to think that the promiſe was binding. In our opinion, he ought to have given a poſitive deciſion. It was no matter whether the promiſe was extorted or not: the promiſe was made; and the queſtion was now, whether or not was the performance lawful? That it was lawful appears evident. The lady was under a moral obligation to remain a widow; and no moral obligation, ſo far as we know, required her to marry.

To be fruitful and multiply, indeed, is declared in Scripture, and is found, to the woful experience of many, to be one of the general laws of our nature. But of all thoſe laws intended by nature to regulate the conduct of inferior intelligences, the moral, which were meant to be checks and correctors of thoſe abuſes to which the phyſical are apt to be carried, are certainly the moſt ſacred and obligatory. To procreate his ſpecies, a man is not then to be guilty of adultery, nor of fornication, nor to liſten to the lewd calls of incontinency. St Paul's obſervation, that it is better to marry than burn, cannot be allowed in this inſtance to have much weight. He has not defined what degree of amorous inflammation conſtitutes burning, nor in what caſes this burning would be a ſufficient warrant for marrying. In the preſent inſtance he does not even conſider marriage as a duty; he compares it with burning, and thinks it only the leaſt of the two evils. Not that marriage is evil of itſelf; for he that marrieth doth well: but there are circumſtances in which it would be inconvenient to marry, and in which he that marrieth not is ſaid to do better. But if thoſe inconveniences be reaſons ſufficient to deter from marrying, is that perſon to be held excuſable who, in order to gratify an animal paſſion, ſomewhat refined, ſhould violate an oath, and trample on a ſacred moral obligation?

Promiſe.

21 Moral laws ſuperior to phyſical in point of obligation.

The young lady might indeed declare that her earthly happineſs was at an end if ſhe were not permitted to marry again: but what circumſtance prevented her from marrying? It was not the opinion of her own paſtor, nor the biſhop of Oxford: the truth is, it was certain ſcruples of her own, which being unable of herſelf to overcome, ſhe had piouſly ſolicited the aſſiſtance of others. It is certainly a misfortune that a devotional and amorous turn ſhould always be ſo cloſely connected in the females. Both, however, cannot always be indulged. Who will ſay, that the motive is rational which inclines one to cheriſh a paſſion which conſcience diſapproves? The virtue of continency might indeed have borne hard on this lady's conſtitution, and in her way to immortal happineſs might have formed a gate ſo ſtrait and narrow as it might be difficult for her to paſs through: but after all, her caſe was not harder than that of nuns, who take the vows of perpetual chaſtity, and endure ſufferings of a ſimilar nature, and in ſome inſtances even perhaps greater than hers; yet doing it cheerfully, from the ſuppoſition that the Omniſcient is well acquainted with the nature of the great ſacrifice which they make, and that after death he will ſtudy to requite them, and beſtow on them ſomething like an equivalent, which in their opinion can ſcarcely be leſs than a happineſs in heaven as ample as their wiſhes and as laſting as their ſouls.

Every promiſe, therefore, which is not releaſed, nor fraudently obtained by the promiſee, is to be held binding if the performance be lawful and poſſible.

22 A promiſe of a ſimilar nature with an oath.

The Chriſtian cannot, and a man of honour will ſcarcely venture to reject this maxim, that a good man ought not to change though he ſwear to his hurt. Yet a ſimple promiſe and a promiſſory oath are not very different in point of obligation. Moſt people know, and, where any moral duty is concerned, they ought particularly to reflect, that this world is governed by an Almighty Being, who knows all things, who lives always, and who is juſt to reward and to puniſh. The perſon who makes a promiſſory oath does it avowedly under an immediate ſenſe of theſe truths; the perſon who makes a ſimple promiſe, though he certainly ought, yet may not reflect on theſe at the time. The former, when he violates his oath, exhibits, only to outward

Promontory || Pronunciation.

appearance, a greater contempt of the Divine power, knowledge, and juſtice, than he who violates a ſimple promiſe under an impreſſion of the ſame truths. To Him who knows the ſecrets of the heart, the breach of the promiſe muſt appear as criminal as the breach of the oath. See ASSUMPSIT and OATH.

PROMONTORY, in geography, a high point of land or rock projecting out into the ſea; the extremity of which towards the ſea is called a *cape* or *headland*. See Plate CCXII.

PROMPTER, in the drama, an officer poſted behind the ſcenes, whoſe buſineſs it is to watch attentively the actors ſpeaking on the ſtage, in order to ſuggeſt and put them forward when at a ſtand, to correct them when amiſs, &c. in their parts.

PROMULGATED, or PROMULGED, ſomething publiſhed or proclaimed, and generally applied to a law, to denote the publiſhing or proclaiming it to the people.

PRONAOS, in the ancient architecture, a porch to a church, palace, or other ſpacious building. See the article PORCH.

PRONATION, among anatomiſts. The radius of the arm has two kinds of motions, the one called *pronation*, the other *ſupination*. Pronation is that whereby the palm of the hand is turned downwards; and ſupination, the oppoſite motion thereto, is that whereby the back of the hand is turned downwards. The peculiar muſcles whereby pronation is performed, are called *pronatores*, as thoſe by which ſupination is performed are termed *ſupinatores*. See ANATOMY, *Table of the Muſcles*, and *Plates*.

PRONG-HOE, in huſbandry, a term uſed to expreſs an inſtrument uſed to hoe or break the ground near and among the roots of plants.

The ordinary contrivance of the hoe is very defective, it being only made for ſcraping on the ſurface; but the great uſe of hoeing being to break and open the ground, beſide the killing of the weeds, which the ancients, and many among us, have thought the only uſe of the hoe, this dull and blunt inſtrument is by no means calculated for the purpoſes it is to ſerve. The prong-hoe conſiſts of two hooked points of ſix or ſeven inches long, and when ſtruck into the ground will ſtir and remove it the ſame depth as the plough does, and thus anſwer both the ends of cutting up the weeds and opening the land. It is uſeful even in the horſe-hoeing huſbandry, becauſe the hoe-plough can only come within three or four inches of the rows of the corn, turnips, and the like; whereas this inſtrument may be uſed afterwards, and with it the land may be raiſed and ſtirred even to the very ſtalk of the plant. See AGRICULTURE and HOE.

PRONOUN, PRONOMEN, in grammar, a declinable part of ſpeech, which being put inſtead of a noun, points out ſome perſon or thing. See GRAMMAR.

PRONUNCIATION, in grammar, the manner of articulating or ſounding the words of a language.

Pronunciation makes the moſt difficult part of written grammar; in regard that a book expreſſing itſelf to the eyes, in a matter that wholly concerns the ears, ſeems next akin to that of teaching the blind to diſtinguiſh colours: hence it is that there is no part ſo defective in grammar as that of pronunciation, as the writer has frequently no term whereby to give the reader an idea of the ſound he would expreſs; for want of a proper term, therefore, he ſubſtitutes a vicious and precarious one. To give a juſt idea of the pronunciation of a language, it ſeems neceſſary to fix as nearly as poſſible all the ſeveral ſounds employed in the pronunciation of that language. Cicero tells us, that the pronunciation underwent ſeveral changes among the Romans: and indeed it is more precarious in the living languages, being, as Du Bos tells us, ſubſervient to faſhion in theſe. The French language is clogged with a difficulty in pronunciation from which moſt others are free; and it conſiſts in this, that moſt of their words have two different pronunciations, the one in common proſe, the other in verſe. Pronunciation.

As to the pronunciation of the Engliſh language, the ingenious Mr Martin, in his Spelling-Book of Arts and Sciences, lays down the following rules: 1. The final *(e)* lengthens the ſound of the foregoing vowel; as in *can, cane; rob, robe; tun, tune*. &c. 2. The final *(e)*, in words ending in *re*, is ſounded before the *r* like *u*; as *maſſacre, maſſa-cur; lucre, lu-cur*, &c. 3. The Latin diphthongs *æ, œ*, are ſounded like *e*; as *Ætna, Etna; œconomy, economy*, &c.: but at the end of the words *oe* ſounds like *o*; as in *toe, foe*, &c. 4. Alſo the Engliſh improper diphthongs, *ea, eo, eu, ue*, ſound only the *e* and *u*; as *tea* or *te*; *feoffee* or *feffee*; *due* or *du*; *true* or *tru*, &c. though ſometimes *eo* and *ea* are pronounced like *ee*, as in *people, fear, near*, &c. 5. Sometimes the diphthong *(ie)* is pronounced like *e* in *cieling*, like *ee* in *field*, and, at the end of words, always like *y*, as in *lie*, &c.; and *ei* is pronounced either like *e* or *ai*, as in *deceit, reign*, &c. 6. The triphthong *eau* is pronounced like *o*, in *beau* and *jet d'eau*; and *ieu* ſounds like *u* in *lieu, adieu*, &c. 7. The ſound of *c* is hard before the vowels *a, o, u*, as in *call, cold, cup*, &c.; alſo ſometimes before *h*, as in *chart, cold*, &c.; and before *l* and *r*, as in *clear, creep*, &c. It is otherwiſe generally ſoft, as in *city, cell, cyder, child*, &c. 8. In French words *ch* is ſounded like *ſh*, as in *chagreen, machine*; and ſometimes like *qu*, as in *choir*. 9. The ſound of *g* is hard before *a, o, u, l, r*, as in *gall, go, gum, glean, grope*; alſo before *ui*, as in *guilt, guild*, &c.; and before *h*, as in *ghoſt*; ſometimes before *i*, as in *gibbous, gibberiſh*. It is alſo generally hard before *e*, as in *get, geld*, &c.; but ſoft in many words derived from the Greek and Latin, as in *geometry, genealogy, genus*, &c. Two *gg* are always hard, as in *dagger*, &c. The ſound of *g*, when ſoft, is like that of *j*. 10. In any part of a word, *ph* ſounds like *f*, as in *philoſophy*, &c. 11. The ſound of *qu*, at the end of French words, is like *k*, as in *riſque*, &c. 12. The ſyllables *ti* and *ci*, if followed by a vowel, ſound like *ſi* or *ſhi*; as in *fiction, logician*, &c. 13. When *cc* occurs before *i*, the firſt is hard and the latter is ſoft; as in *flaccid*, &c. 14. The letter *p* is not pronounced at the beginning of ſyllables before *ſ* and *t*; as in *pſalm, ptarmics*, &c. As to other peculiarities regarding the pronunciation of ſingle letters, many of them have been taken notice of at the beginning of each, in the courſe of this work.

But it is not enough to know the juſt pronunciation of ſingle letters, but alſo of words: in order to which, the accenting of words ought to be well underſtood; ſince nothing is more harſh and diſagreeable to the ear, than to hear a perſon ſpeak or read with wrong accents. And indeed in Engliſh the ſame word is often both

Pronunciation, Proof.

both a noun and a verb, distinguished only by the accent, which is on the first syllable of the noun, and on the last of the verb; as *fèrment* and *fermènt*; *rècord* and *recòrd*, &c. We are to observe also, that in order to a just expression of words, some require only a single accent on the syllable, as in *tórment*, &c.; but in others it should be marked double, as in *anı́mal*, because it is pronounced as if the letter was wrote double, viz. *annimal*.

Mr Sheridan's Dictionary will be found extremely useful as a directory in acquiring the pronunciation of the English language; but care must be taken to avoid his provincial brogue, which has certainly misled him in several instances. Mr Walker's Pronouncing Dictionary, lately published, will likewise deserve the student's attention. It is a work of great labour and merit, and is highly useful. It has indeed some faults and inaccuracies, but it is notwithstanding, in all probability, the best of the kind.

PRONUNCIATION is also used for the fifth and last part of rhetoric, which consists in varying and regulating the voice agreeably to the matter and words, so as most effectually to persuade and touch the hearers. See ORATORY, Part IV.

PROOF, in law and logic, is that degree of evidence which carries conviction to the mind. It differs from demonstration, which is applicable only to those truths of which the contrary is inconceivable. It differs likewise from probability, which produces for the most part nothing more than opinion, while proof produces belief. See PROBABILITY.

The *proof* of crimes was anciently effected among our ancestors divers ways; viz. by duel or combat, fire, water, &c. See DUEL and ORDEAL.

PROOF of Artillery and Small Arms, is a trial whether they stand the quantity of powder allotted for that purpose. The rule of the board of ordnance is, that all guns, under 24-pounders, be loaded with powder as much as their shot weighs; that is, a brass 24-pounder with 21 lb. a brass 32-pounder with 26 lb. 12 oz. and a 42-pounder with 31 lb. 8 oz.; the iron 24-pounder with 18 lb. the 32-pounder with 21 lb. 8 oz. and the 42-pounder with 25 lb.

The brass light field-pieces are proved with powder that weighs half as much as their shot, except the 24-pounder, which is loaded with 10 lb only.

Government allows 11 bullets of lead in the pound for the proof of muskets, and 14.5, or 29 in two pounds, for service; 17 in the pound for the proof of carabines, and 20 for service; 28 in the pound for the proof of pistols, and 34 for service.

When guns of a new metal, or of lighter construction, are proved; then, besides the common proof, they are fired 200 or 300 times, as quick as they can be, loaded with the common charge given in actual service. Our light 6-pounders were fired 300 times in 3 hours 27 minutes, loaded with 1 lb. 4 oz. without receiving any damage.

PROOF of Powder, is in order to try its goodness and strength. See GUNPOWDER.

PROOF of Cannon, is made to ascertain their being well cast, their having no cavities in their metal, and, in a word, their being fit to resist the effort of their charge of powder. In making this proof, the piece is laid upon the ground, supported only by a piece of wood in the middle, of about 5 or 6 inches thick, to raise the muzzle a little; and then the piece is fired against a solid butt of earth. Proof.

Tools used in the PROOF of Cannon are as follow:

Searcher, an iron socket with branches, from 4 to 8 in number, bending outwards a little, with small points at their ends: to this socket is fixed a wooden handle, from 8 to 12 feet long, and 1½ inch in diameter. This searcher is introduced into the gun after each firing, and turned gently round to discover the cavities within: if any are found, they are marked on the outside with chalk; and then the

Searcher with one point is introduced: about which point a mixture of wax and tallow is put, to take the impression of the holes; and if any are found of one-fourth of an inch deep, or of any considerable length, the gun is rejected as unserviceable to the government.

Reliever, is an iron ring fixed to a handle, by means of a socket, so as to be at right angles; it serves to disengage the first searcher, when any of its points are retained in a hole, and cannot otherwise be got out. When guns are rejected by the proof-masters, they order them to be marked × thus, which the contractors generally alter *WP* thus; and after such alteration, dispose of them to foreign powers for Woolwich proof.

The most curious instrument for finding the principal defects in pieces of artillery, was lately invented by lieutenant-general Desaguliers, of the royal regiment of artillery. This instrument, grounded on the truest mechanical principles, is no sooner introduced into the hollow cylinder of the gun, than it discovers its defects, and more particularly that of the piece not being truly bored; which is a very important one, and to which most of the disasters happening to pieces of artillery are in a great measure to be imputed; for, when a gun is not truly bored, the most expert artillerist will not be able to make a good shot.

PROOF of Mortars and Howitzers, is made to ascertain their being well cast, and of strength to resist the effort of their charge. For this purpose the mortar or howitzer is placed upon the ground, with some part of their trunnions or breech sunk below the surface, and resting on wooden billets, at an elevation of about 70 degrees.

The mirror is generally the only instrument to discover the defects in mortars and howitzers. In order to use it, the sun must shine; the breech must be placed towards the sun, and the glass over-against the mouth of the piece: it illuminates the bore and chamber sufficiently to discover the flaws in it.

PROOF of Foreign Brass-Artillery. 1st, The Prussians. Their battering-train and garrison artillery are proved with a quantity of powder equal to ½ the weight of the shot, and fired 75 rounds as fast as in real service; that is, 2 or 3 rounds in a minute. Their light field-train, from a 12-pounder upwards, are proved with a quantity of powder = 1-3d of the weight of the shot, and fired 150 rounds, at 3 or 4 rounds in a minute. From a 12-pounder downwards, are proved with a quantity of powder = 1-5th of the shot's weight, and fired 300 rounds, at 5 or 6 rounds each minute, properly spunged and loaded. Their mortars are proved with the chambers full of powder, and the shells loaded. Three rounds are fired as quick as possible.

2d, The Dutch prove all their artillery by firing each

Proof, Propagation.

each piece 5 times; the two firſt rounds with a quantity of powder = 2-3ds of the weight of the ſhot; and the three laſt rounds with a quantity of powder = ½ the weight of the ſhot.

3d, The French the ſame as the Dutch.

PROOF, in brandy and other ſpirituous liquors, is a little white lather which appears on the top of the liquor when poured into a glaſs. This lather, as it diminiſhes, forms itſelf into a circle called by the French the *chapelet*, and by the Engliſh the *bead* or *bubble*.

Nichols's Life of Hogarth.

PROOFS of Prints, were anciently a few impreſſions taken off in the courſe of an engraver's proceſs. He proved a plate in different ſtates, that he might aſcertain how far his labours had been ſucceſsful, and when they were complete. The excellence of ſuch early impreſſions, worked with care, and under the artiſt's eye, occaſioning them to be greedily ſought after, and liberally paid for, it has been cuſtomary among our modern printſellers to take off a number of them, amounting, perhaps to hundreds, from every plate of conſiderable value; and yet their want of rareneſs has by no means abated their price. On retouching a plate, it has been alſo uſual, among the ſame conſcientious fraternity, to cover the inſcription, which was immediately added after the firſt proofs were obtained, with ſlips of paper, that a number of ſecondary proofs might alſo be created.

PROOF, in the ſugar trade. See SUGAR.

PROOFS, in printing. See PRINTING, p. 524, col. 2.

PROPAGATION, the act of multiplying the kind. See GENERATION.

PROPAGATION of Plants. The moſt natural and the moſt univerſal way of propagating plants is by ſeeds. See PLANTS, and NATURAL HISTORY, p. 654. But they may alſo be propagated by *ſets*, *pieces*, or *cuttings*, taken from the parent plant. Willows are very eaſily propagated by ſets: ſuch as riſe to be conſiderable timber trees being raiſed from ſets 7 or 8 feet long, ſharpened at their larger ends, which are thruſt into the ground by the ſides of ditches, on the banks of rivers, or in any moiſt ſoil. The fallow trees are raiſed from ſets only 3 feet long. The plane tree, mint, &c. may be propagated in the ſame way. In providing the ſlips, ſprigs, or cuttings, however, care muſt be taken to cut off ſuch branches as have knots or joints 2 or 3 inches beneath them; ſmall top ſprigs of 2 or 3 years growth are the beſt for this operation. Plants are alſo propagated by parting their roots, each part of which, properly managed, ſends out freſh roots. Another mode of propagating plants is by layering or laying the tops of the branches in the ground.

The method of layering is this: Dig a ring-trench round the ſtool, of a depth ſuitable to the nature of the plant; and having pitched upon the ſhoots to be layered, bend them to the bottom of the trench (either with or without plaſhing, as may be found moſt convenient), and there *peg* them faſt; or, putting ſome mould upon them, *tread* them hard enough to prevent their ſpringing up again—fill in the mould—place the top of the layer in an upright poſture, treading the mould hard behind it; and cut it carefully off above the firſt, ſecond, or third eye. Plants are alſo propagated by their bulbs.

The number of vegetables that may be propagated from an individual is very remarkable, eſpecially in the moſt minute plants. The annual product of one ſeed even of the common mallow has been found to be no leſs than 200,000; but it has been ſince proved, by a ſtrict examination into the more minute parts of the vegetable world, that ſo deſpiſed a plant as the common wall moſs produces a much more numerous offspring. In one of the little heads of this plant there have been counted 13824 ſeeds. Now allotting to a root of this plant eight branches, and to each branch ſix heads, which appears to be a very moderate computation, the produce of one ſeed is $6 \times 13824 = 82944$; and 8×82944, gives 663,552 ſeeds as the annual produce of one ſeed, and that ſo ſmall that 13824 of them are contained in a capſule, whoſe length is but one ninth of an inch, its diameter but one 23d of an inch, and its weight but the 13th part of a grain.

Proper ‖ Property.

For the propagation or culture of particular plants, ſee AGRICULTURE, Part II. ſect. 3. p. 288. and HUSBANDRY.

PROPER, ſomething natural and eſſentially belonging to any thing.

PROPERTIUS (Sextus Aurelius), a celebrated Latin poet, born at Mevania, a city of Umbria, now called *Bevagna*, in the duchy of Spoletto. He went to Rome after the death of his father, a Roman knight, who had been put to death by order of Auguſtus, for having followed Antony's party during the triumvirate. Propertius in a ſhort time acquired great reputation by his wit and abilities, and had a conſiderable ſhare in the eſteem of Mæcenas and Cornelius Gallus. He had alſo Ovid, Tibullus, Baſſus, and the other ingenious men of his time, for his friends. He died at Rome 19 B. C. He is printed with almoſt all the editions of Tibullus and Catullus: but the beſt edition of him is that which was given ſeparately by Janus Brouckhuſius at Amſterdam, 1702, in 4to, and again in 1714, 4to. *cum curis ſecundis ejuſdem.* We have four books of his Elegies or Amours with a lady called *Hoſtia*, or *Hoſtilia*, to whom he gave the name of *Cynthia*.

PROPERTY, in a general ſenſe, is a particular virtue or quality which nature has beſtowed on ſome things excluſive of all others: thus, colour is a property of light; extenſion, figure, diviſibility, and impenetrability, are properties of body.

1 Definition.

PROPERTY, in law, is deſcribed to be the higheſt right which a perſon has or can have to any thing.

2 The original foundation of the right to property not generally conſidered.

There is nothing which ſo generally ſtrikes the imagination, and engages the affections of mankind, as the right of property; or that ſole and deſpotic dominion which one man claims and exerciſes over certain external things of the world, in total excluſion of the right of any other individual in the univerſe. And yet there are very few that will give themſelves the trouble to conſider the original and foundation of this right. Pleaſed as we are with the poſſeſſion, we ſeem afraid to look back to the means by which it was acquired, as if fearful of ſome defect in our title; or at beſt we reſt ſatisfied with the deciſion of the laws in our favour, without examining the reaſon or authority upon which thoſe laws have been built. We think it enough that our title is derived by the grant of the former proprietor, by deſcent from our anceſtors, or by the laſt will and teſtament of the dying owner: not caring to reflect, that (accurately and ſtrictly ſpeaking) there is no foundation in nature or in natural law, why a ſet of words upon parchment ſhould convey the dominion of land; why the ſon ſhould have a right to exclude his fellow-creatures from a de-

Property. a determinate ſpot of ground, becauſe his father had done ſo before him; or why the occupier of a particular field or of a jewel, when lying on his death-bed and no longer able to maintain poſſeſſion, ſhould be entitled to tell the reſt of the world which of them ſhould enjoy it after him. Theſe inquiries, it muſt be owned, would be uſeleſs and even troubleſome in common life. It is well if the maſs of mankind will obey the laws when made, without ſcrutinizing too nicely into the reaſons of making them. But when law is to be conſidered not only as a matter of practice, but alſo as a rational ſcience, it cannot be improper or uſeleſs to examine more deeply the rudiments and grounds of theſe poſitive conſtitutions of ſociety.

3 This right ariſes from a divine grant.

In the beginning of the world, we are informed by holy writ, that the all-bountiful Creator gave to man "dominion over all the earth; and over the fiſh of the "ſea, and over the fowl of the air, and over every li-"ving thing that moveth upon the earth." This is the only true and ſolid foundation of man's dominion over external things, whatever airy metaphyſical notions may have been ſtarted by fanciful writers upon this ſubject. The earth, therefore, and all things therein, are the general property of all mankind, excluſive of other beings, from the immediate gift of the Creator. And, while the earth continued thinly inhabited, it is reaſonable to ſuppoſe, that all was in common among them, and that every one took from the public ſtock to his own uſe ſuch things as his immediate neceſſities required.

4 The ſtate of property in the early ages of the world.

Theſe general notions of property were then ſufficient to anſwer all the purpoſes of human life; and might perhapsſtill have anſwered them, had it been poſſible for mankind to have remained in a ſtate of primæval ſimplicity: as may be collected from the manners of many American nations, when firſt diſcovered by the Europeans; and from the ancient method of living among the firſt Europeans themſelves, if we may credit either the memorials of them preſerved in the golden age of the poets, or the uniform accounts given by hiſtorians of thoſe times wherein *erant omnia communia et indiviſa omnibus, veluti unum cunctis patrimonium eſſet*. Not that this communion of goods ſeems ever to have been applicable, even in the earlieſt ages, to aught but the *ſubſtance* of the thing; nor could it be extended to the *uſe* of it. For, by the law of nature and reaſon, he who firſt began to uſe it, acquired therein a kind of tranſient property, that laſted ſo long as he was uſing it, and no longer: or, to ſpeak with greater preciſion, the *right* of poſſeſſion continued for the ſame time only that the *act* of poſſeſſion laſted. Thus the ground was in common, and no part of it was the permanent property of any man in particular; yet whoever was in the occupation of any determinate ſpot of it, for reſt, for ſhade, or the like, acquired for the time a ſort of ownerſhip, from which it would have been unjuſt, and contrary to the law of nature, to have driven him by force; but the inſtant that he quitted the uſe or occupation of it, another might ſeize it without injuſtice. Thus alſo a vine or other tree might be ſaid to be in common, as all were equally entitled to its produce; and yet any private individual might gain the ſole property of the fruit, which he had gathered for his own repaſt. A doctrine well illuſtrated by Cicero, who compares the world to a great theatre, which is common to the public, and yet the place which any man has taken is for the time his own.

Blackſt. Comment.

6

But when mankind increaſed in number, craft, and ambition, it became neceſſary to entertain conceptions of more permanent dominion; and to appropriate to individuals, not the immediate *uſe* only, but the very *ſubſtance* of the thing to be uſed: otherwiſe innumerable tumults muſt have ariſen, and the good order of the world been continually broken and diſturbed, while a variety of perſons were ſtriving who ſhould get the firſt occupation of the ſame thing, or diſputing which of them had actually gained it. As human life alſo grew more and more refined, abundance of conveniencies were deviſed to render it more eaſy, commodious, and agreeable; as habitations for ſhelter and ſafety, and raiment for warmth and decency. But no man would be at the trouble to provide either, ſo long as he had only an uſufructuary property in them, which was to ceaſe the inſtant that he quitted poſſeſſion;—if, as ſoon as he walked out of his tent, or pulled off his garment, the next ſtranger who came by would have a right to inhabit the one and to wear the other. In caſe of habitations in particular, it was natural to obſerve, that even the brute creation, to whom every thing elſe was in common, maintained a permanent property in their dwellings, eſpecially for the protection of their young; that the birds of the air had neſts, and the beaſts of the field had caverns, the invaſion of which they eſteemed a very flagrant injuſtice, and would ſacrifice their lives to preſerve them. Hence a property was ſoon eſtabliſhed in every man's houſe and home-ſtall; which ſeem to have been originally mere temporary huts or moveable cabins, ſuited to the deſign of Providence for more ſpeedily peopling the earth, and ſuited to the wandering life of their owners, before any extenſive property in the ſoil or ground was eſtabliſhed. And there can be no doubt, but that moveables of every kind became ſooner appropriated than the permanent ſubſtantial ſoil: partly becauſe they were more ſuſceptible of a long occupancy, which might be continued for months together without any ſenſible interruption, and at length by uſage ripen into an eſtabliſhed right; but principally becauſe few of them could be fit for uſe, till improved and meliorated by the bodily labour of the occupant; which bodily labour, beſtowed upon any ſubject which before lay in common to all men, is univerſally allowed to give the faireſt and moſt reaſonable title to an excluſive property therein.

Property. 5 Riſe of permanent property in various things.

61 In food and other neceſſary articles.

The article of food was a more immediate call, and therefore a more early conſideration. Such as were not contented with the ſpontaneous product of the earth ſought for a more ſolid refreſhment in the fleſh of beaſts, which they obtained by hunting. But the frequent diſappointments incident to that method of proviſion induced them to gather together ſuch animals as were of a more tame and ſequacious nature; and to eſtabliſh a permanent property in their flocks and herds, in order to ſuſtain themſelves in a leſs precarious manner, partly by the milk of their dams, and partly by the fleſh of the young. The ſupport of theſe their cattle made the article of *water* alſo a very important point. And therefore the book of Geneſis (the moſt venerable monument of antiquity, conſidered merely with a view to hiſtory) will furniſh us with frequent inſtances of violent contentions concerning wells; the excluſive property of which appears to have been eſtabliſhed in the firſt digger or occupant, even in ſuch places where the ground and herbage

7 Nature of patriarchal property.

remained

Property. remained yet in common. Thus we find Abraham, who was but a ſojourner, aſſerting his right to a well in the country of Abimelech, and exacting an oath for his ſecurity, "becauſe he had digged that well." And Iſaac, about 90 years afterwards, reclaimed this his father's property; and, after much contention with the Philiſtines, was ſuffered to enjoy it in peace.

All this while the ſoil and paſture of the earth remained ſtill in common as before, and open to every occupant: except perhaps in the neighbourhood of towns, where the neceſſity of a ſole and excluſive property in lands (for the ſake of agriculture) was earlier felt, and therefore more readily complied with. Otherwiſe, when the multitude of men and cattle had conſumed every convenience on one ſpot of ground, it was deemed a natural right to ſeize upon and occupy ſuch other lands as would more eaſily ſupply their neceſſities. This practice is ſtill retained among the wild and uncultivated nations that have never been formed into civil ſtates, like the Tartars and others in the eaſt; where the climate itſelf, and the boundleſs extent of their territory, conſpire to retain them ſtill in the ſame ſavage ſtate of vagrant liberty, which was univerſal in the earlieſt ages, and which Tacitus informs us continued among the Germans till the decline of the Roman empire. We have alſo a ſtriking example of the ſame kind in the hiſtory of Abraham and his nephew Lot. When their joint ſubſtance became ſo great, that paſture and other conveniencies grew ſcarce, the natural conſequence was, that a ſtrife aroſe between their ſervants; ſo that it was no longer practicable to dwell together. This contention Abraham endeavoured to compoſe: "Let there be no ſtrife, I pray thee, between thee and me. Is not the whole land before thee? Separate thyſelf, I pray thee, from me: If thou wilt take the left hand, then I will go to the right; or if thou depart to the right hand, then I will go to the left." This plainly implies an acknowledged right, in either, to occupy whatever ground he pleaſed, that was not pre-occupied by other tribes. "And Lot lifted up his eyes, and beheld all the plain of Jordan, that it was well watered everywhere, even as the garden of the Lord. Then Lot choſe him all the plain of Jordan, and journeyed eaſt; and Abraham dwelt in the land of Canaan."

Upon the ſame principle was founded the right of migration, or ſending colonies to find out new habitations, when the mother-country was overcharged with inhabitants; which was practiſed as well by the Phœnicians and Greeks, as the Germans, Scythians, and other northern people. And, ſo long as it was confined to the ſtocking and cultivation of deſert uninhabited countries, it kept ſtrictly within the limits of the law of nature.

8 Neceſſity of property and of laws reſpecting it.

But as the world by degrees grew more populous, it daily became more difficult to find out new ſpots to inhabit, without encroaching upon former occupants; and by conſtantly occupying the ſame individual ſpot, the fruits of the earth were conſumed, and its ſpontaneous produce deſtroyed, without any proviſion for a future ſupply or ſucceſſion. It therefore became neceſſary to purſue ſome regular method of providing a conſtant ſubſiſtence; and this neceſſity produced, or at leaſt promoted and encouraged, the art of agriculture. And the art of agriculture, by a regular connection and conſequence, introduced and eſtabliſhed the idea of a more permanent property in the ſoil than had hitherto been received and adopted. It was clear that the earth would not produce her fruits in ſufficient quantities without the aſſiſtance of tillage; but who would be at the pains of tilling it, if another might watch an opportunity to ſeize upon and enjoy the product of his induſtry, art, and labour? Had not therefore a ſeparate property in lands, as well as moveables, been veſted in ſome individuals, the world muſt have continued a foreſt, and men have been mere animals of prey; which, according to ſome philoſophers, is the genuine ſtate of nature. Whereas now (ſo graciouſly has Providence interwoven our duty and our happineſs together) the reſult of this very neceſſity has been the ennobling of the human ſpecies, by giving it opportunities of improving in *rational* faculties, as well as of exerting its *natural*. Neceſſity begat property: and in order to inſure that property, recourſe was had to civil ſociety, which brought along with it a long train of inſeparable concomitants; ſtates, government, laws, puniſhments, and the public exerciſe of religious duties. Thus connected together, it was found that a part only of ſociety was ſufficient to provide, by their manual labour, for the neceſſary ſubſiſtence of all; and leiſure was given to others to cultivate the human mind, to invent uſeful arts, and to lay the foundations of ſcience.

Property. Property.

9 Property acquired firſt by occupancy.

The only queſtion remaining is, How this property became actually veſted; or what it is that gave a man an excluſive right to retain in a permanent manner that ſpecific land which before belonged generally to every body, but particularly to nobody? And as we before obſerved, that *occupancy* gave the right to the temporary *uſe* of the ſoil; ſo it is agreed upon all hands, that occupancy gave alſo the original right to the permanent property in the *ſubſtance* of the earth itſelf, which excludes every one elſe but the owner from the uſe of it. There is indeed ſome difference among the writers on natural law, concerning the reaſon why occupancy ſhould convey this right, and inveſt one with this abſolute property: Grotius and Puffendorf inſiſting, that this right of occupancy is founded upon a tacit and implied aſſent of all mankind, that the firſt occupant ſhould become the owner; and Barbeyrac, Titius, Mr Locke, and others, holding, that there is no ſuch implied aſſent, neither is it neceſſary that there ſhould be; for that the very act of occupancy, alone, being a degree of bodily labour, is from a principle of natural juſtice, without any conſent or compact, ſufficient of itſelf to gain a title. A diſpute that ſavours too much of nice and ſcholaſtic refinement. However, both ſides agree in this, that occupancy is the thing by which the title was in fact originally gained; every man ſeizing to his own continued uſe ſuch ſpots of ground as he found moſt agreeable to his own convenience, provided he found them unoccupied by any one elſe.

10 By what means it is preſerved or loſt.

Property, both in lands and moveables, being thus originally acquired by the firſt taker, which taking amounts to a declaration, that he intends to appropriate the thing to his own uſe, it remains in him, by the principle of univerſal law, till ſuch time as he does ſome other act which ſhows an intention to abandon it; for then it becomes, naturally ſpeaking, *publici juris* once more, and is liable to be again appropriated

Property. ted by the next occupant. So if one is poſſeſſed of a jewel, and caſts it into the ſea or a public highway, this is ſuch an expreſs dereliction, that a property will be veſted in the firſt fortunate finder that ſhall ſeize it to his own uſe. But if he hides it privately in the earth, or other ſecret place, and it is diſcovered, the finder acquires no property therein; for the owner hath not by this act declared any intention to abandon it, but rather the contrary: and if he loſes or drops it by accident, it cannot be collected from thence that he deſigned to quit the poſſeſſion; and therefore in ſuch caſe the property ſtill remains in the loſer, who may claim it again of the finder. And this, we may remember, is the doctrine of the Engliſh law with relation to *Treasure-Trove*.

But this method, of one man's abandoning his property, and another ſeizing the vacant poſſeſſion, however well founded in theory, could not long ſubſiſt in fact. It was calculated merely for the rudiments of civil ſociety, and neceſſarily ceaſed among the complicated intereſts and artificial refinements of polite and eſtabliſhed governments. In theſe it was found, that what became inconvenient or uſeleſs to one man, was highly convenient and uſeful to another; who was ready to give in exchange for it ſome equivalent that was equally deſirable to the former proprietor. This mutual convenience introduced commercial traffic, and the reciprocal transfer of property by ſale, grant, or conveyance: which may be conſidered either as a continuance of the original poſſeſſion which the firſt occupant had; or as an abandoning of the thing by the preſent owner, and an immediate ſucceſſive occupancy of the ſame by the new proprietor. The voluntary dereliction of the owner, and delivering the poſſeſſion to another individual, amount to a transfer of the property; the proprietor declaring his intention no longer to occupy the thing himſelf, but that his own right of occupancy ſhall be veſted in the new acquirer. Or, taken in the other light, if I agree to part with an acre of my land to Titius, the deed of conveyance is an evidence of my intending to abandon the property; and Titius, being the only or firſt man acquainted with ſuch my intention, immediatly ſteps in and ſeizes the vacant poſſeſſion: thus the conſent expreſſed by the conveyance gives Titius a good right againſt me; and poſſeſſion or occupancy confirms that right againſt all the world beſides.

11 How it goes on the death of the occupant.

The moſt univerſal and effectual way of abandoning property is by the death of the occupant: when, both the actual poſſeſſion and intention of keeping poſſeſſion ceaſing, the property, which is founded upon ſuch poſſeſſion and intention, ought alſo to ceaſe of courſe. For, naturally ſpeaking, the inſtant a man ceaſes to be, he ceaſes to have any dominion: elſe, if he had a right to diſpoſe of his acquiſitions one moment beyond his life, he would alſo have a right to direct their diſpoſal for a million of ages after him; which would be highly abſurd and inconvenient (A). All property muſt therefore ceaſe upon death, conſidering men as abſolute individuals, and unconnected with civil ſociety: for then, by the principles before eſtabliſhed, the next immediate occupant would acquire a right in all that the deceaſed poſſeſſed. But as, under civilized governments, which are calculated for the peace of mankind, ſuch a conſtitution would be productive of endleſs diſturbances, the univerſal law of almoſt every nation (which is a kind of ſecondary law of nature) has either given the dying perſon a power of continuing his property, by diſpoſing of his poſſeſſions by will; or, in caſe he neglects to diſpoſe of it, or is not permitted to make any diſpoſition at all, the municipal law of the country then ſteps in, and declares who ſhall be the ſucceſſor, repreſentative, or heir of the deceaſed; that is, who alone ſhall have a right to enter upon this vacant poſſeſſion, in order to avoid that confuſion which its becoming again common would occaſion. And farther, in caſe no teſtament be permitted by the law, or none be made, and no heir can be found ſo qualified as the law requires, ſtill, to prevent the robuſt title of *occupancy* from again taking place, the doctrine of eſcheats is adopted in almoſt every country; whereby the ſovereign of the ſtate, and thoſe who claim under his authority, are the ultimate heirs, and ſucceed to thoſe inheritances to which no other title can be formed. Property.

12 Of the right of inheritance.

The right of inheritance, or deſcent to the children and relations of the deceaſed, ſeems to have been allowed much earlier than the right of deviſing by teſtament. We are apt to conceive at the firſt view that it has nature on its ſide; yet we often miſtake for nature what we find eſtabliſhed by long and inveterate cuſtom. It is certainly a wiſe and effectual, but clearly a political, eſtabliſhment; ſince the permanent right of property, veſted in the anceſtor himſelf, was no *natural*, but merely a *civil*, right. It is true, that the tranſmiſſion of one's poſſeſſions to poſterity has an evident tendency to make a man a good citizen and a uſeful member of ſociety: it ſets the paſſions on the ſide of duty, and prompts a man to deſerve well of the public, when he is ſure that the reward of his ſervices will not die with himſelf, but be tranſmitted to thoſe with whom he is connected by the deareſt and moſt tender affections. Yet, reaſonable as this foundation of the right of inheritance may ſeem, it is probable that its immediate original aroſe not from ſpeculations altogether ſo delicate and refined, and, if not from fortuitous circumſtances, at leaſt from a plainer and more ſimple principle. A man's children or neareſt relations are uſually about him on his death-bed, and are the earlieſt witneſſes of his deceaſe. They became therefore generally the next immediate occupants, till at length in proceſs of time this frequent uſage ripened into general law. And therefore alſo in the earlieſt ages, on failure of children, a man's ſervants born under his roof were allowed to be his heirs; being immediately on the ſpot when he died. For we find the old patriarch Abraham expreſsly declaring, that "ſince God had given him no ſeed, his ſteward Eliezer, one born in his houſe, was his heir."

While property continued only for life, teſtaments were

(A) This right, inconvenient as it certainly is, the law of Scotland gives to every man over his *real* eſtate, by authoriſing him to entail it on his heirs for ever. See Law, clxxx. 9, 10, 11. and Tailzie.

Property.

were uſeleſs and unknown; and when it became inheritable, the inheritance was long indefeaſible, and the children or heirs at law were incapable of excluſion by will. Till at length it was found, that ſo ſtrict a rule of inheritance made heirs diſobedient and headſtrong, defrauded creditors of their juſt debts, and prevented many provident fathers from dividing or charging their eſtates as the exigence of their families required. This introduced pretty generally the right of diſpoſing of one's property, or a part of it, by *teſtament*; that is, by written or oral inſtructions properly *witneſſed* and authenticated, according to the *pleaſure* of the deceaſed; which we therefore emphatically ſtyle his *will*. This was eſtabliſhed in ſome countries much later than in others. In England, till modern times, a man could only diſpoſe of one-third of his moveables from his wife and children; and, in general, no will was permitted of lands till the reign of Henry VIII. and then only of a certain portion; for it was not till after the Reſtoration that the power of deviſing real property became ſo univerſal as at preſent.

13 Laſt wills or teſtaments

14 Are creatures of the civil or municipal laws. *Blackſt. Comment.*

Wills, therefore, and teſtaments, rights of inheritance, and ſucceſſions, are all of them creatures of the civil or municipal laws, and accordingly are in all reſpects regulated by them; every diſtinct country having different ceremonies and requiſites to make a teſtament completely valid; neither does any thing vary more than the right of inheritance under different national eſtabliſhments. In England particularly, this diverſity is carried to ſuch a length, as if it had been meant to point out the power of the laws in regulating the ſucceſſion to property, and how futile every claim muſt be that has not its foundation in the poſitive rules of the ſtate. In perſonal eſtates, the father may ſucceed to his children; in landed property, he never can be their immediate heir by any the remoteſt poſſibility: in general, only the eldeſt ſon, in ſome places only the youngeſt, in others all the ſons together, have a right to ſucceed to the inheritance: In real eſtates, males are preferred to females, and the eldeſt male will uſually exclude the reſt; in the diviſion of perſonal eſtates, the females of equal degree are admitted together with the males, and no right of primogeniture is allowed.

15 Scruples reſpecting heritable property removed.

This one conſideration may help to remove the ſcruples of many well-meaning perſons, who ſet up a miſtaken conſcience in oppoſition to the rules of law. If a man diſinherits his ſon, by a will duly executed, and leaves his eſtate to a ſtranger, there are many who conſider this proceeding as contrary to natural juſtice; while others ſo ſcrupulouſly adhere to the ſuppoſed intention of the dead, that if a will of lands be atteſted by only *two* witneſſes inſtead of *three*, which the law requires, they are apt to imagine that the heir is bound in conſcience to relinquiſh his title to the deviſee. But both of them certainly proceed upon very erroneous principles: as if, on the one hand, the ſon had by nature a right to ſucceed to his father's lands; or as if, on the other hand, the owner was by nature entitled to direct the ſucceſſion of his property after his own deceaſe. Whereas the law of nature ſuggeſts, that on the death of the poſſeſſor, the eſtate ſhould again become common, and be open to the next occupant, unleſs otherwiſe ordered, for the ſake of civil peace, by the poſitive law of ſociety. The poſitive law of ſociety, which is with us the municipal laws of England and Scotland, directs it to veſt in ſuch perſon as the laſt proprietor ſhall by will, attended with certain requiſites, appoint; and, in defect of ſuch appointment, to go to ſome particular perſon, who, from the reſult of certain local conſtitutions, appears to be the heir at law. Hence it follows, that, where the appointment is regularly made, there cannot be a ſhadow of right in any one but the perſon appointed: and, where the neceſſary requiſites are omitted, the right of the heir is equally ſtrong and built upon as ſolid a foundation, as the right of the deviſee would have been, ſuppoſing ſuch requiſites were obſerved. Property.

16 Of things that are ſtill in common.

But, after all, there are ſome few things, which, notwithſtanding the general introduction and continuance of property, muſt ſtill unavoidably remain in common; being ſuch wherein nothing but an uſufructuary property is capable of being had: and therefore they ſtill belong to the firſt occupant, during the time he holds poſſeſſion of them, and no longer. Such (among others) are the elements of light, air, and water; which a man may occupy by means of his windows, his gardens, his mills, and other conveniences: ſuch alſo are the generality of thoſe animals which are ſaid to be *feræ naturæ*, or of a wild and untameable diſpoſition; which any man may ſeize upon and keep for his own uſe or pleaſure. All theſe things, ſo long as they remain in poſſeſſion, every man has a right to enjoy without diſturbance; but if once they eſcape from his cuſtody, or he voluntarily abandons the uſe of them, they return to the common ſtock, and any other man has an equal right to ſeize and enjoy them afterwards.

17 Of ſimilar things which have been appropriated.

Again, there are other things in which a permanent property may ſubſiſt, not only as to the temporary uſe, but alſo the ſolid ſubſtance; and which yet would be frequently found without a proprietor, had not the wiſdom of the law provided a remedy to obviate this inconvenience. Such are foreſts and other waſte grounds, which were omitted to be appropriated in the general diſtribution of lands: ſuch alſo are wrecks, eſtrays, and that ſpecies of wild animals, which the arbitrary conſtitutions of poſitive law have diſtinguiſhed from the reſt by the well-known appellation of *game*. With regard to theſe and ſome others, as diſturbances and quarrels would frequently ariſe among individuals contending about the acquiſition of this ſpecies of property by firſt occupancy, the law has therefore wiſely cut up the root of diſſenſion, by veſting the things themſelves in the ſovereign of the ſtate; or elſe in his repreſentatives appointed and authoriſed by him, being uſually the lords of manors. And thus our legiſlature has univerſally promoted the grand ends of civil ſociety, the peace and ſecurity of individuals, by ſteadily purſuing that wiſe and orderly maxim, of aſſigning to every thing capable of ownerſhip a legal and determinate owner.

18 The reaſoning of thoſe who contend for an equalization of property,

In this age of paradox and innovation, much has been ſaid of *liberty* and *equality*; and ſome few have contended for an equalization of property. One of the wildeſt declaimers on this ſubject, who is for aboliſhing property altogether, has (inadvertently we ſuppoſe) given a complete confutation, not only of his own arguments, but alſo of the arguments of all who have

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have written, or, we think, can write, on the ſame ſide of the queſtion. After labouring to prove that it is groſs injuſtice in any man to retain more than is abſolutely neceſſary to ſupply him with food, clothes, and ſhelter, this zealous reformer ſtates an objection to his theory, ariſing from the well-known allurements of ſloth, which, if the accumulation of property were not permitted, would baniſh induſtry from the whole world. The objection he urges fairly, and anſwers it thus: "It may be obſerved, that the equality for which we are pleading is an equality that would ſucceed to a ſtate of great intellectual improvement. So bold a revolution cannot take place in human affairs, till the general mind has been highly cultivated. The preſent age of mankind is greatly enlightened; but it is to be feared is not yet enlightened enough. Haſty and undigeſted tumults may take place under the idea of an equalization of property; but it is only a calm and clear conviction of juſtice, of juſtice mutually to be rendered and received, of happineſs to be produced by the *deſertion of our moſt rooted habits*, that can introduce an invariable ſyſtem of this ſort. Attempts without this preparation will be productive only of confuſion. Their effect will be momentary, and a new and more barbarous inequality will ſucceed. Each man with unaltered appetite will watch his opportunity to gratify his love of power, or his love of diſtinction, by uſurping on his inattentive neighbours."

2 The effect of ignorance of human nature.

Theſe are juſt obſervations, and ſuch as we have often made to ourſelves on the various propoſed reformations of government. The illumination which the author requires before he would introduce his abolition of property, would conſtitute men more than angels; for to be under the influence of no paſſion or appetite, and to be guided in every action by unmixed benevolence and pure intellect, is a degree of perfection which we can attribute to no being inferior to God. But it is the object of the greater part of this writer's book to prove that all men muſt arrive at ſuch perfection before his ideal republic can contribute to their happineſs; and therefore every one who is conſcious of being at any time ſwayed by paſſion, and who feels that he is more attached to his wife or children than to ſtrangers, will look without envy to the preſent inequalities of property and power, if he be an intelligent diſciple of Mr Godwin.

Literary PROPERTY. See *Copy-Right*.

1 Definition.

PROPHECY is a word derived from προφημι, and in its original import ſignifies the prediction of future events.

2 Prophecy proves a ſupernatural communion with the Deity

As God alone can perceive with certainty the future actions of free agents, and the remote conſequences of thoſe laws of nature which he himſelf eſtabliſhed, prophecy, when clearly fulfilled, affords the moſt convincing evidence of an intimate and ſupernatural communion between God and the perſon who uttered the prediction. Together with the power of working miracles, it is indeed the only evidence which can be given of ſuch a communion. Hence among the profeſſors of every religious ſyſtem, except that which is called the religion of nature, there have been numberleſs pretenders to the gift of prophecy. The Pagan nations of antiquity had their oracles, augurs, and ſoothſayers. Modern idolaters have their necromancers and diviners; and the Jews, Chriſtians, and Mahometans, have their ſeers and prophets.

3 The profeſſors of all religions have pretended to it.

Prophecy.

The ill-founded pretenſions of paganiſm, ancient and modern, have been expoſed under various articles of this work. (See DIVINATION, MAGIC, NECROMANCY, and MYTHOLOGY). And the claims of the Arabian impoſtor are examined under the articles ALCORAN and MAHOMETANISM; ſo that at preſent we have only to conſider the uſe, intent, and truth, of the Jewiſh and Chriſtian prophecies.

4 The word in Scripture has various meanings.

Previous to our entering on this inveſtigation, it may be proper to obſerve, that in the Scriptures of the Old and New Teſtaments, the ſignification of the word prophecy is not always confined to the foretelling of future events. In ſeveral inſtances it is of the ſame import with preaching, and denotes the faculty of illuſtrating and applying to preſent practical purpoſes the doctrines of prior revelation. Thus in Nehemiah it is ſaid, "Thou haſt appointed prophets to preach * ;" and whoever ſpeaketh unto men to edification, and exhortation, and comfort, is by St Paul called a *prophet* †. Hence it was that there were ſchools of prophets in Iſrael, where young men were inſtructed in the truths of religion, and fitted to exhort and comfort the people.

* Ch. vi. v. 7

† 1 Cor. ch. xiv. v. 3.

In this article, however, it is chiefly of importance to confine ourſelves to that kind of prophecy which, in declaring truths either paſt, preſent, or future, required the immediate inſpiration of God.

5 Science and religion gradually acquired.

Every one who looks into the hiſtory of the world muſt obſerve, that the minds of men have from the beginning been gradually opened by a train of events ſtill improving upon, and adding light to each other; as that of each individual is, by proceeding from the firſt elements and ſeeds of ſcience, to more enlarged views, and a ſtill higher growth. Mankind neither are nor ever have been capable of entering into the depths of knowledge at once; of receiving a whole ſyſtem of natural or moral truths together; but muſt be let into them by degrees, and have them communicated by little and little, as they are able to bear it. That this is the caſe with reſpect to human ſcience, is a fact which cannot be queſtioned; and there is as little room to queſtion it with reſpect to the progreſs of religious knowledge among men, either taken collectively or in each individual. Why the caſe is thus in both, why all are not adult at once in body and mind, is a queſtion which the religion of nature is equally called upon with revelation to anſwer. The fact may not be eaſily accounted for, but the reality of it is incontrovertible.

6 The revelation of the Old Teſtament gradual.

Accordingly, the great object of the ſeveral revelations recorded in the Old Teſtament was evidently to keep alive a ſenſe of religion in the minds of men, and to train them by degrees for the reception of thoſe ſimple but ſublime truths by which they were to be ſaved. The notions which the early deſcendants of Adam entertained of the Supreme Being, and of the relation in which they ſtood to him, were probably very groſs; and we ſee them gradually refined by a ſeries of revelations or prophecies, each in ſucceſſion more explicit than that by which it was preceded, till the advent of Him who was the way, the truth, and the life, and who brought to light life and immortality.

When a revelation was made of any important truth, the grounds of which the mind of man has not facul-

Prophecy.

ties to comprehend, that revelation, though undoubtedly a prophecy, muſt have been ſo far from confirming the truth of revealed religion in general, that it could not gain credit itſelf, but by ſome extrinſic evidence that it came indeed from God. Hence we find Moſes, after it was revealed to him from the burning buſh that he ſhould deliver his countrymen from Egyptian bondage, replying, "Behold, they will not believe me, nor hearken to my voice; for they will ſay, the Lord hath not appeared unto thee." This revelation certainly conſtituted him a prophet to Iſrael; and there cannot be a doubt but that he perfectly knew the divine ſource from which he received it: but he very naturally and reaſonably concluded, that the children of Iſrael would not believe that the Lord had appeared to him, unleſs he could give them ſome other proof of this preternatural appearance than his own ſimple affirmation of its reality. This proof he was immediately enabled to give, by having conferred upon him the power of working miracles in confirmation of his prophecy. Again, when Gideon was called to the deliverance of Iſrael, the angel of the Lord came and ſaid unto him, "The Lord is with thee, thou mighty man of valour: go in this thy might, and thou ſhalt ſave Iſrael from the hand of the Midianites. Have not I ſent thee?" Here was a prophecy delivered by the angel of the Lord to encourage Gideon's undertaking: but he, being probably afraid of ſome illuſion of ſenſe or imagination, demanded a ſign that he was really an angel who talked with him. A ſign is accordingly given him, a miraculous ſign, with which he is ſatisfied, and undertakes the work appointed him.

7 Prophecy always accompanied by miracles,

8 And of itſelf can be no proof of a revelation.

From theſe and many ſimilar tranſactions recorded in the Old Teſtament, it appears that prophecy was never intended as evidence of an original revelation. It is indeed, by its very nature, totally unfit for ſuch a purpoſe; becauſe it is impoſſible, without ſome extrinſic proof of its divine origin, to know whether any prophecy be true or falſe, till the era arrive at which it ought to be fulfilled. When it is fulfilled, it affords complete evidence that he who uttered it ſpake by the ſpirit of God, and that the doctrines which he taught of a religious nature, were all either dictated by the ſame ſpirit, or at leaſt are true, and calculated to direct mankind in the way of their duty.

9 It was intended to preſerve a ſenſe of religion among men.

The prophecies vouchſafed to the patriarchs in the moſt early periods of the world, were all intended to keep alive in their minds a ſenſe of religion, and to direct their views to the future completion of that firſt and greateſt prophecy which was made to Adam immediately on his fall: but in order to ſecure credit to thoſe prophecies themſelves, they were always accompanied by ſome miraculous ſign that they were indeed given by the God of truth, and not the deluſions of fanaticiſm or hypocriſy. Prophecy, in the proper ſenſe of the word, commenced with the fall; and the firſt inſtance of it is implied in the ſentence denounced upon the original deceiver of mankind; "I will put enmity between thee and the woman, and between thy ſeed and her ſeed: It ſhall bruiſe thy head, and thou ſhalt bruiſe his heel."

10 Probable effects of the firſt prophecy on our firſt parents.

This prophecy, though one of the moſt important that ever was delivered, when conſidered by itſelf, is exceedingly obſcure. That Adam ſhould have underſtood it, as ſome of his degenerate ſons have pretended to do, in a literal ſenſe, is abſolutely impoſſible. He knew well that it was the great God of heaven and earth who was ſpeaking, and that ſuch a Being was incapable of trifling with the wretchedneſs of his fallen creature. The ſentence denounced upon himſelf and his wife was awful and ſevere. The woman was doomed to ſorrow in conception; the man to ſorrow and travel all the days of his life. The ground was curſed for his ſake; and the end of the judgment was, "Duſt thou art, and to duſt thou ſhalt return." Had our firſt parents been thus left, they muſt have looked upon themſelves as rejected by their Maker, delivered up to trouble and ſorrow in the world, and as having no hope in any other. With ſuch impreſſions on their minds they could have retained no ſenſe of religion; for religion, when unaccompanied by hope, is a ſtate of frenzy and diſtraction: yet it is certain that they could have no hope from any thing expreſsly recorded by Moſes, except what they might draw from this ſentence paſſed on their deceiver. Let us then endeavour to aſcertain what conſolation it could afford them. Prophecy.

At that awful juncture, they muſt have been ſenſible that their fall was the victory of the ſerpent, whom by experience they had found to be an enemy to God and to man. It could not therefore but be ſome comfort to them to hear this enemy firſt condemned, and to ſee that, however he had prevailed againſt them, he had gained no victory over their Maker. By his condemnation they were ſecured from thinking that there was any malignant being equal to the Creator in power and dominion; an opinion which, through the prevelancy of evil, gained ground in after times, and was deſtructive of all true religion. The belief of God's ſupreme dominion being thus preſerved, it was ſtill neceſſary to give them ſuch hopes as might induce them to love as well as to fear him; and theſe they could not but conceive when they heard from the mouth of their Creator and Judge, that the ſerpent's victory was not complete even over themſelves; that they and their poſterity ſhould be enabled to conteſt his empire; and that though they were to ſuffer much in the ſtruggle, they ſhould yet finally prevail, bruiſe the ſerpent's head, and deliver themſelves from his power and dominion.

This prophecy therefore was to our firſt parents a light ſhining in a dark place. All that they could certainly conclude from it was, that their caſe was not deſperate; that ſome remedy, ſome deliverance from the evil they were under, would in time appear; but *when* or *where*, or by *what means* they were to be delivered, they could not poſſibly underſtand, unleſs the matter was further revealed to them, as probably it was at the inſtitution of ſacrifice (See Sacrifice). Obſcure, however, as this promiſe or prophecy was, it ſerved after the fall as a foundation for religion, and truſt and confidence towards God in hopes of deliverance in time from the evils of diſobedience: and this appears to have been the ſole purpoſe for which it was given, and not, as ſome well-meaning though weak advocates for Chriſtianity have imagined, as a prediction pointing *directly* to the croſs of Chriſt.

As this prophecy was the firſt, ſo is it the only conſiderable one in which we have any concern from the creation to the days of Noah. It was proportioned to the then wants and neceſſities of the world, and was the grand charter of God's mercy after the fall. Nature had

Prophecy. had no certain help for ſinners; her rights were loſt with her innocence. It was therefore neceſſary either to deſtroy the offenders, or to raiſe them to a capacity of ſalvation, by giving them ſuch hopes as might enable them to exerciſe a reaſonable religion. So far the light of this prophecy extended. By what *means* God intended to work their ſalvation, he did not expreſsly declare: and who has a right to complain that he did not, or to preſcribe to him rules in diſpenſing his mercy to the children of men?

11 The curſe removed from the ground.

Upon the hopes of mercy which this prophecy gives in very general terms, mankind reſted till the birth of Noah. At that period a new prophecy was delivered by Lamech, who foretels that his ſon ſhould comfort them concerning the work and toil of their hands, "becauſe of the *earth which the Lord had curſed.*" We are to remember that the curſe pronounced upon the earth was part of the ſentence paſſed upon our firſt parents; and when that part was remitted, if it ever was remitted, mankind would acquire new and more lively hopes that in God's good time they ſhould be freed from the whole. But it has been ſhown by biſhop Sherlock*, that this declaration of Lamech's was a prediction, that during the life of his ſon the curſe ſhould be taken off from the earth: and the ſame prelate has proved with great perſpicuity, and in the moſt ſatisfactory manner, that this happy revolution actually took place after the flood. The limits preſcribed to an article of this kind will not permit us even to abridge his arguments. We ſhall only obſerve, that the truth of his concluſion is manifeſt from the very words of ſcripture; for when God informs Noah of his deſign to deſtroy the world, he adds, "But with thee will I eſtabliſh my covenant:" and as ſoon as the deluge was over, he declared that he "would not again curſe the ground any more for man's ſake; but that while the earth ſhould remain, ſeed-time and harveſt, and cold and heat, and ſummer and winter, and day and night, ſhould not ceaſe." From this laſt declaration it is apparent that a curſe *had* been on the earth, and that ſeed-time and harveſt had often failed; that the curſe was now taken off; and that in conſequence of this covenant, as it is called, with Noah and his ſeed and with every living creature, mankind ſhould not henceforth be ſubjected to toil ſo ſevere and ſo generally fruitleſs.

* *Uſe and Intent of Prophecy.*

12 A future life not then explicitly revealed.

It may ſeem ſurpriſing perhaps to ſome, that after ſo great a revolution in the world as the deluge made, God ſhould ſay nothing to the remnant of mankind of the puniſhments and rewards of another life, but ſhould make a new covenant with them relating merely to fruitful ſeaſons and the bleſſings of the earth. But in the ſcriptures we ſee plainly a gradual working of providence towards the redemption of the world from the curſe of the fall; that the temporal bleſſings were firſt reſtored as an earneſt and pledge of better things to follow; and that the covenant given to Noah had, ſtrictly ſpeaking, nothing to do with the hopes of futurity, which were reſerved to be the matter of another covenant, in another age, and to be revealed by him, whoſe province it was to "bring life and immortality to light through the goſpel." But if Noah and his forefathers expected deliverance from the whole curſe of the fall, the actual deliverance from one part of it was a very good pledge of a further deliverance to be expected in time. Man himſelf was curſed as well as the ground; he was doomed to duſt: and fruitful ſeaſons are but a ſmall relief, compared to the greatneſs of his loſs. But when fruitful ſeaſons came, and one part of the curſe was evidently abated, it gave great aſſurance that the other ſhould not laſt for ever, but that by ſome means, ſtill unknown to them, they ſhould be freed from the whole, and finally bruiſe the ſerpent's head, who, at the deluge, had ſo ſeverely bruiſed man's heel. Prophecy.

Upon this aſſurance mankind reſted for ſome generations, and practiſed, as we have every reaſon to believe, a rational worſhip to the one God of the univerſe. At laſt, however, idolatry was by ſome means or other introduced (ſee POLYTHEISM), and ſpread ſo univerſally through the world, that true religion would in all probability have entirely failed, had not God viſibly interpoſed to preſerve ſuch a ſenſe of it as was neceſſary for the accompliſhment of his great deſign to reſtore mankind. This he did by calling Abraham from amidſt his idolatrous kindred, and renewing to him the word of prophecy: "Get thee out of thy country (ſaid he), and from thy kindred, and from thy father's houſe, unto a land that I will ſhew thee. And I will make of thee a great nation, and I will bleſs thee and make thy name great; and thou ſhalt be a bleſſing. And I will bleſs them that bleſs thee, and curſe him that curſeth thee; and in thee ſhall all the families of the earth be bleſſed." Theſe magnificent promiſes are ſeveral times repeated to the father of the faithful with additional circumſtances of great importance, ſuch as, "that he ſhould be multiplied exceedingly; that he ſhould be a father of many nations; that kings ſhould come out of him;" and above all, that God would eſtabliſh an *everlaſting covenant* with him and his ſeed, to give him and them all the land of Cannan for an *everlaſting poſſeſſion*, and to be *their God.*" 13 Promiſe to Abraham,

Upon ſuch of theſe promiſes as relate to temporal bleſſings we need not dwell. They are much of the ſame nature with thoſe which had been given before to Lamech, Noah, Shem, and Japheth; and all the world knows how amply and literally they have been fulfilled. There was however ſo little probability in nature of their accompliſhment at the time when they were made, that we find the patriarch aſking "Whereby he ſhould *know* † that he ſhould inherit ſuch an extent of country?" And as the promiſes that he ſhould inherit it were meant to be a foundation for religion and confidence in God, a miraculous ſign was given him that they came indeed from the ſpirit of truth. This removed from his mind every doubt, and made him give the fulleſt credit, not only to them, but alſo to that other promiſe, "that in his ſeed ſhould all the nations of the earth be bleſſed."

† Geneſis xv. 8. &c.

What diſtinct notion he had of this bleſſing, or in what manner he hoped it ſhould be effected, we cannot pretend to ſay. "But that he underſtood it to be a promiſe of reſtoring mankind, and delivering them from the remaining curſe of the fall, there can be no doubt. He knew that death had entered by ſin; he knew that God had promiſed victory and redemption to the ſeed of the woman. Upon the hopes of this reſtoration the religion of his anceſtors was founded; and when God, from whom this bleſſing on all men was expected, did expreſsly promiſe a bleſſing on all men, and in this promiſe founded his everlaſting covenant—what could Abraham elſe expect but the completion in his ſeed of that ancient promiſe and prophecy concerning the victory

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Prophecy. to be obtained by the woman's ſeed? The curſe of the ground was expiated in the flood, and the earth reſtored with a bleſſing, which was the foundation of the temporal covenant with Noah; a large ſhare of which God expreſsly grants to Abraham and his poſterity particularly, together with a promiſe to bring, by their means, a new and further bleſſing upon the whole race of men. If we lay theſe things to heart, we cannot ſuppoſe that leſs could be expected from the new promiſe or prophecy given to Abraham than a deliverance from that part of the curſe ſtill remaining on men: *Duſt thou art, and to duſt thou ſhalt return.* In virtue of this covenant Abraham and his poſterity had reaſon to expect that the time would come when man ſhould be called from his duſt again. For this expectation they had his aſſurance who gave the covenant, that he would be their God for ever. Well might our Saviour then tell the ſons of Abraham, that even Moſes at the buſh ſhowed the reſurrection of the dead, when he called the Lord the God of Abraham, and the God of Iſaac, and the God of Jacob *." "

* Sherlock's *Uſe and Intent of Prophecy.*

These promiſes made to Abraham were renewed to Iſaac and Jacob; to the laſt of whom it was revealed, not only that all the nations of the earth ſhould be bleſſed in his ſeed, but that the bleſſing ſhould ſpring from his ſon Judah. It is, however, by no means evident that any one of thoſe patriarchs knew preciſely by what *means* (A) the curſe of the fall was to be entirely removed, and all men called from their duſt again. It was enough that they were convinced of the fact in general terms, ſince ſuch conviction was a ſufficient foundation of a rational religion; and the deſcendants of Abraham had no other foundation upon which to reſt their hopes, and pay a cheerful worſhip to the God of their fathers, till the giving of the law to Moſes. Then indeed they were incorporated into a ſociety with municipal laws of their own and placed under a theocratic government; the temporal promiſes made to their fathers were amply fulfilled; religion was maintained among them by rewards and puniſhments equally diſtributed in this world (ſee THEOLOGY): and a ſeries of prophets ſucceeding one another pointed out with greater and greater clearneſs, as the fulneſs of time approached, the perſon who was to redeem mankind from the power of death; by what means he was to work that great redemption, and at what preciſe period he was to make his appearance in the world. By theſe ſupernatural interpoſitions of divine providence, the principles of pure theiſm and the practice of true religion were preſerved among the children of Iſrael, when all other nations were ſunk in the groſſeſt idolatry, and wallowed in the moſt abominable vices; when the far-famed Egyptians, Greeks, and Romans, fell down with adoration to ſtocks and ſtones and the vileſt reptiles; and when they had no well grounded hope of another life, and were in fact without God in the world.

14 To Iſaac and Jacob.

15 The law of Moſes and the ſucceeding prophets

From this ſhort deduction, we think ourſelves intitled to conclude, that the *primary* uſe and intent of prophecy, under the various diſpenſations of the Old Teſtament, was not, as is too often ſuppoſed, to eſtabliſh the divine miſſion of Jeſus Chriſt, but to keep alive in the minds of thoſe to whom it was given, a ſenſe of religion, and a hope of future deliverance from the curſe of the fall. It was, in the expreſſive language of St Peter, "a light that ſhone in a dark place, unto which men did well to take heed until the day dawned and the day-ſtar aroſe in their hearts." But though this was certainly the original intent of prophecy (for Chriſt, had he never been foretold, would have proved himſelf to be the Son of God with power by his aſtoniſhing miracles, and his reſurrection from the dead), yet it cannot be denied, that a long ſeries of prophecies, given in different and far diſtant ages, and having all their completion in the life, death, and reſurrection, of Jeſus, concur very forcibly with the evidence of miracles to prove that he was the ſeed of the woman ordained to bruiſe the head of the ſerpent, and reſtore man to his forfeited inheritance. To the Jews the force of this evidence muſt have been equal, if not ſuperior, to that of miracles themſelves; and therefore we find the Apoſtles and firſt preachers of the goſpel, in their addreſſes to them conſtantly appealing to the law and the prophets, whilſt they urged upon the Gentiles the evidence of miracles.

Prophecy.

16 Were all intended to keep alive a ſenſe of religion.

17 The prophecies to be conſidered in connection.

In order to form a right judgment of the argument for the truth of Chriſtianity drawn from the ſure word of prophecy, we muſt not conſider the prophecies given in the Old Teſtament as ſo many *predictions* only independent of each other; for if we do, we ſhall totally loſe ſight of the purpoſe for which they were originally given, and ſhall never be able to ſatisfy ourſelves when confronted by the objections of unbelievers. It is eaſy for men of leiſure and tolerable parts to find difficulties in particular predictions, and in the application of them made by writers, who lived many hundred years ago, and who had many ancient books and records of the Jewiſh church, from which they drew many paſſages, and perhaps ſome prophecies; which books and records we have not to enable us to underſtand, and to juſtify their applications. But it is not ſo eaſy a matter to ſhow, or to perſuade the world to believe, that a chain of prophecies reaching through ſeveral thouſand years, delivered at different times, yet manifeſtly ſubſervient to one and the ſame adminiſtration of providence from beginning to end, is the effect of art and contrivance and religious fraud. In examining the ſeveral prophe-

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(A) This they certainly could not know from the promiſes expreſſed in the very general terms in which they are recorded in the book of Geneſis. It is, however, not improbable that thoſe promiſes, as they immediately received them, were conceived in terms more preciſe and particular; and, at all events, Dr Warburton has proved to the full conviction of every man who is not a determined unbeliever, that braham was commanded to ſacrifice his ſon Iſaac, not only as a trial of his obedience, but alſo that God might give him what he earneſtly deſired, a ſcenical repreſentation of the means by which mankind were to be redeemed from death. The learned writer thinks, and his reaſoning compels us to think with him, that to this tranſaction our Saviour alludes when he ſays, "Your father Abraham rejoiced to ſee my *day*, and he ſaw it and was glad."

Prophecy. cies recorded in the Old Teſtament, we are not to ſuppoſe that each of them *expreſsly* pointed out and *clearly* characterized Jeſus Chriſt. Had they done ſo, inſtead of being a ſupport to religion in general, the purpoſe for which they were originally intended, they would have had a very different effect, by making thoſe to whom they were given repine at being placed under diſpenſations ſo very inferior to that of the goſpel. We are therefore to inquire only whether all the notices, which, in general and often metaphorical terms, God gave to the fathers of his intended ſalvation, are perfectly anſwered by the coming of Chriſt; and we ſhall find that nothing has been promiſed with reſpect to that ſubject which has not been performed in the ampleſt manner. If we examine the prophecies in this manner, we ſhall find that there is not one of them, which the Apoſtles have applied to the Meſſiah, that is not applicable in a rational and important ſenſe to ſomething in the birth, life, preaching, death, reſurrection, and aſcenſion of Jeſus of Nazareth; that as applied to him they are all conſiſtent with each other; and that though ſome few of them may be applied without abſurdity to perſons and events under the Jewiſh diſpenſation, Chriſt is the only perſon that ever exiſted in whom they all meet as in a centre. In the limits preſcribed us, it is impoſſible that we ſhould enter upon a particular proof of this poſition. It has been proved by numberleſs writers, and, with reſpect to the moſt important prophecies, by none with greater ſucceſs than biſhop Sherlock in his *Uſe and Intent of Prophecy in the ſeveral ages of the world*; a work which we recommend to our readers as one of the moſt valuable on the ſubject in our own or any other language.

18 Objection from the obſcurity of prophecy,

But admitting that it would have been improper, for the reaſons already hinted at, to have given a clear and preciſe deſcription of Chriſt, and the Chriſtian diſpenſation, to men who were ordained to live under diſpenſations leſs perfect, how, it may be aſked, comes it to paſs that many of the prophecies applied by the writers of the goſpel to our Saviour and his actions are ſtill dark and obſcure, and ſo far from belonging evidently to him and to him only, that it requires much learning and ſagacity to ſhow even now the connection between ſome prophecies and the events?

19 Anſwered.

In anſwer to theſe queſtions, the learned prelate juſt referred to obſerves, "That the obſcurity of prophecy does not ariſe from hence, that it is a relation or deſcription of ſomething *future*; for it is as eaſy to ſpeak of things future plainly, and intelligibly, as it is of things paſt or preſent. It is not, therefore, of the nature of prophecy to be obſcure; for it may eaſily be made, when he who gives it thinks fit, as plain as hiſtory. On the other ſide, a figurative and dark deſcription of a future event will be figurative and dark ſtill when the event happens; and conſequently will have all the obſcurity of a figurative and dark deſcription as well after as before the event. The prophet Iſaiah deſcribes the peace of Chriſt's kingdom in the following manner: 'The wolf ſhall dwell with the lamb, and the leopard ſhall lie down with the kid, and the calf and the young lion, and the fatling, together, and a little child ſhall lead them.' Nobody, ſome modern Jews excepted, ever underſtood this literally; nor can it now be *literally* applied to the ſtate of the goſpel. It was and is capable of different interpretations: it may mean temporal peace, or that internal and ſpiritual peace—that tranquillity of mind, which ſets a man at peace with God, himſelf, and the world. But whatever the true meaning is, this prophecy does no more obtrude one determinate ſenſe upon the mind ſince the coming of Chriſt than it did before. But then we ſay, the ſtate of the goſpel was very properly prefigured in this deſcription, and is as properly prefigured in a hundred more of the like kind; and ſince they all agree in a fair application to the ſtate of the goſpel, we ſtrongly conclude, that this ſtate was the thing foretold under ſuch expreſſions. So that the argument from prophecy for the truth of Chriſtianity does not reſt on this, that the event has neceſſarily limited and aſcertained the particular ſenſe and meaning of every prophecy; but in this, that every prophecy has in a proper ſenſe been completed by the coming of Chriſt. It is abſurd, therefore, to expect clear and evident conviction from every ſingle prophecy applied to Chriſt; the evidence muſt ariſe from a view and compariſon of all together." It is doubtleſs a great miſtake to ſuppoſe that prophecy was intended ſolely or chiefly for their ſakes in whoſe time the events predicted are to happen. What great occaſion is there to lay in ſo long beforehand the evidence of prophecy to convince men of things that are to happen in their own times; the truth of which they may, if they pleaſe, learn from their own ſenſes? Yet ſome people are apt to talk as if they thought the truth of the events predicted depended very much on the evidence of prophecy: they ſpeak, for inſtance, as if they imagined the certainty and reality of our Saviour's reſurrection were much concerned in the clearneſs of the prophecies relating to that great and wonderful event, and ſeem to think that they are confuting the truth of his reſurrection when they are pointing out the abſurdity of the prophecies relating to it. But can any thing be more abſurd? For what ground or pretence is there to inquire whether the prophecies foretelling that the Meſſiah ſhould die and riſe again do truly belong to Chriſt, unleſs we are firſt ſatisfied that Chriſt died and roſe again?

Prophecy.

The part which unbelievers ought to take in this queſtion, if they would make any uſe of prophecy, ſhould be, to ſhow from the prophets that Chriſt was neceſſarily to riſe from the dead; and then to prove that in fact Jeſus never did riſe. Here would be a plain conſequence. But if they like not this method, they ought to let the prophecies alone; for if Chriſt did not riſe, there is no harm done though the prophets have not foretold it. And if they allow the reſurrection of Chriſt, what do they gain by diſcrediting the prophets? The event will be what it is, let the prophecies be what they will.

Theſe conſiderations ſhow how far the goſpel is *neceſſarily* concerned in prophetical evidence, and how clear the prophecies ſhould be. Chriſt claims to be the perſon foretold in the law and the prophets; and as truth muſt ever be conſiſtent with itſelf, this claim muſt be true as well as all others. This is the part then to be tried on the evidence of prophecy: Is Chriſt that perſon deſcribed and foretold under the Old Teſtament or not? Whether all the prophecies relating to him be plain or not plain, it matters little; the ſingle queſtion is, Are there enough plain to ſhow us that Chriſt is the perſon foretold under the Old Teſtament? If there be,

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Prophecy

we are at an end of our inquiry, and want no farther help from prophecy; eſpecially ſince we have ſeen the day dawn and enjoyed the marvellous light of the goſpel of God.

20 Objections from the clearneſs of ſome prophecies,

But ſo unreaſonable are unbelievers, that whilſt ſome of them object to the obſcurity of the prophecies, others have rejected them altogether on account of their clearneſs, pretending that they are hiſtories and not predictions. The prophecies againſt which this objection has been chiefly urged are thoſe of Daniel, which were firſt called in queſtion by the famous Porphyry. He affirmed that they were not compoſed by Daniel, whoſe name they bear, but by ſome author who lived in Judea about the time of Antiochus Epiphanes; becauſe all to that time contained true hiſtory, but that all the facts beyond that were manifeſtly falſe.

21 Anſwered,

This method of oppoſing the prophecies, as a father of the church rightly obſerves, is the ſtrongeſt teſtimony of their truth: for they are ſo exactly fulfilled, that to infidels the prophet ſeemed not to have foretold things future, but to have related things paſt. To an infidel of this age, if he has the ſame ability and knowledge of hiſtory that Porphyry had, all the ſubſequent prophecies of Daniel, except thoſe which are ſtill fulfilling, would appear to be hiſtory and not prophecy: for it entirely overthrows the notion of their being written in the days of *Antiochus Epiphanes*, or of the *Maccabees*, and eſtabliſhes the credit of Daniel as a prophet beyond contradiction, that there are ſeveral of thoſe prophecies which have been fulfilled ſince that period as well as before; nay, that there are prophecies of Daniel which are fulfilling at this very time in the world.

22 From what has happened ſince the objection was firſt ſtarted

Our limits will not permit us to enter into the objections which have been made to this prophet by the author of *The Literal Scheme of Prophecy conſidered*; nor is there occaſion that we ſhould enter into them. They have been all examined and completely anſwered by Biſhop Chandler in his *Vindication of his Defence of Chriſtianity*, by Mr Samuel Chandler in his *Vindication of the Antiquity and Authority of Daniel's Prophecies*, and by Biſhop Newton in his excellent *Diſſertations on the Prophecies*. To theſe authors we refer the reader; and ſhall conclude the preſent article with a view of ſome prophecies given in very remote ages, which are in this age receiving their accompliſhment.

23 And from facts of the preſent age.

Of theſe the firſt is that of Noah concerning the ſervitude of the poſterity of Canaan. In the greater part of original manuſcripts, and in our verſion of the holy ſcriptures, this prophecy is thus expreſſed: "Curſed be Canaan; a ſervant of ſervants ſhall he be unto his brethren:" but in the Arabic verſion, and in ſome copies of the Septuagint, it is, "Curſed be *Ham* the father of Canaan; a ſervant of ſervants ſhall he be to his brethren." Whether the curſe was really pronounced upon Ham, which we think moſt probable, or only upon his ſon Canaan, we ſhall find the prediction remarkably fulfilled, not barely ages after the book of Geneſis was very generally known, but alſo at this very day. It is needleſs to inform any man who has but looked into the Old Teſtament, that when the ancient patriarchs pronounced either a curſe or a bleſſing upon any of their ſons, they meant to declare the future fortunes, not of that ſon individually, but of his deſcendants as a tribe or a nation. Let us keep this in mind, and proceed to compare with Noah's prophecy *firſt* the fortunes of the deſcendants of Canaan, the fourth ſon of Ham, and then the fortunes of the poſterity of Ham by his other ſons. Prophecy.

With the fate of the Canaanites every reader is acquainted. They were conquered by Joſhua ſeveral centuries after the delivery of this prophecy; and ſuch of them as were not exterminated were by him and Solomon reduced to a ſtate of the loweſt ſervitude to the Iſraelites, the poſterity of Shem the brother of Ham. The Greeks and Romans, too, who were the deſcendants of Japheth, not only ſubdued Syria and Paleſtine, but alſo purſued and conquered ſuch of the Canaanites as were anywhere remaining, as for inſtance the Tyrians and Carthaginians, of whom the former were ruined by Alexander and the Grecians, and the latter by Scipio and the Romans. Nor did the effects of the curſe ſtop there. The miſerable remainder of that devoted people have been ever ſince ſlaves to a foreign yoke; firſt to the Saracens who are deſcended from Shem, and afterwards to the Turks who are deſcended from Japheth; and under the Turkiſh dominion they groan at this day.

If we take the prophecy as it ſtands in the Arabic verſion, its accompliſhment is ſtill more remarkable. The whole continent of Africa was peopled principally by the poſterity of Ham. And for how many ages have the better parts of that country lain under the dominion firſt of the Romans, then of the Saracens, and now of the Turks? In what wickedneſs, ignorance, barbarity, ſlavery, and miſery, live moſt of its inhabitants? and of the poor negroes how many thouſands are every year ſold and bought like beaſts in the market, and conveyed from one quarter of the world to do the work of beaſts in another; to the full accompliſhment indeed of the prophecy, but to the laſting diſgrace of thoſe who are from the love of gain the inſtruments of fulfilling it. Nothing can be more complete than the execution of the ſentence as well upon Ham as upon Canaan; and the hardieſt infidel will not dare to ſay that it was pronounced after the event.

The next prophecy which we ſhall notice is that of Abraham concerning the multitude of his deſcendants; which every one knows is ſtill fulfilled in the Jews even in their diſperſed ſtate, and therefore cannot have been given after the event of which it ſpeaks.

Of the ſame kind are the ſeveral prophecies concerning Iſhmael; of which ſome have been fulfilled, and others are at preſent fulfilling in the moſt aſtoniſhing manner. Of this ſon of Abraham it was foretold, that "he ſhould be a wild man; that his hand ſhould be againſt every man, and every man's hand againſt him; that he ſhould dwell in the preſence of all his brethren; that he ſhould be multiplied exceedingly, beget twelve princes, and become a great nation." The ſacred hiſtorian who records theſe prophecies adds, that "God was with the lad, and he grew, and dwelt in the wilderneſs, and became an archer."

To ſhow how fully and literally all theſe prophecies have been accompliſhed, would require more room than we have to beſtow; and to the reader of hiſtory the labour would be ſuperfluous. We ſhall therefore only requeſt the unbeliever to attend to the hiſtory of the Arabs, the undoubted deſcendants of Iſhmael; and to ſay how it comes to paſs, that though they have been robbers by land and pirates by ſea for time immemorial,

Prophecy. rial, though their hands have been againſt every man, and every man's hand againſt them, they always have dwelt, and at this day dwell, in the preſence of their brethren, a free and independent people. It cannot be pretended that no attempt has ever been made to conquer them; for the greateſt conquerors in the world have all in their turns attempted it: but though ſome of them made great progreſs, not one was ever crowned with ſucceſs. It cannot be pretended that the inacceſſibleneſs of their country has been their protection; for their country has been often penetrated, though it never was entirely ſubdued. When in all human probability they have been on the brink of ruin, they were ſignally and providentially delivered. Alexander was preparing an expedition againſt them, when he was cut off in the flower of his age. Pompey was in the career of his conqueſts, when urgent affairs called him elſewhere. Ælius Gallius had penetrated far into their country, when a fatal diſeaſe deſtroyed great numbers of his men, and obliged him to return. Trajan beſieged their capital city, but was defeated by thunder and lightning and whirlwinds. Severus beſieged the ſame city twice, and was twice repelled from before it. The Turks, though they were able to wreſt from them their foreign conqueſts, have been ſo little able to ſubdue the Arabs themſelves, or even to reſtrain their depredations, that they are obliged to pay them a ſort of annual tribute for the ſafe paſſage of the pilgrims who go to Mecca to pay their devotions. On theſe facts we ſhall not exclaim. He who is not ſtruck upon comparing the ſimple hiſtory of this ſingular people with the prophecies ſo long ago delivered of them and their great anceſtor, whoſe love of liberty is compared to that of the wild aſs, would riſe wholly unmoved from our exclamations.

24 The diſperſion of the Jews plainly foretold,

A fourth prophecy of this kind, which cannot be alleged to have been uttered after the event, is the denunciation of Moſes againſt the children of Iſrael in caſe of their diſobedience; which is ſo literally fulfilled, that even at this moment it appears rather a hiſtory of the preſent ſtate of the Jews, than a remote prediction of their apoſtacy and puniſhment. "And the Lord ſhall ſcatter thee among all people from the one end of the earth even unto the other. And among theſe nations ſhalt thou find no eaſe, neither ſhall the ſole of thy foot have reſt; but the Lord ſhall give thee there a trembling heart, and failing of eyes, and ſorrow of mind. And thy life ſhall hang in doubt before thee; and thou ſhalt fear day and night, and ſhalt have none aſſurance of thy life." (Deut. xxviii. 64, 65, 66.) "And thou ſhalt become an aſtoniſhment, a proverb, and a bye-word, among all nations, whither the Lord ſhall lead you." (Deut xxviii. 37.)

Similar to this denunciation, but attended with ſome circumſtances ſtill more wonderful, is the following prediction of the prophet Hoſea: "The children of Iſrael ſhall abide many days without a king, and without a prince, and without a ſacrifice, and without an image, and without an ephod, and without teraphim. Afterwards ſhall the children of Iſrael return, and ſeek the Lord their God, and David their king; and ſhall fear the Lord and his goodneſs in the latter days (A)" In this paſſage we find the ſtate of the Jews for the laſt 1700 years clearly and diſtinctly deſcribed with all its circumſtances. From the time that they rejected their Meſſiah all things began to work towards the deſtruction of their polities both civil and religious; and within a few years from his death, their city, temple, and government, were utterly ruined; and they themſelves, not carried into a gentle captivity, to enjoy their laws, and live under governors of their own as they did in Babylon, but they were ſold like beaſts in a market, and became ſlaves in the ſtricteſt ſenſe; and from that day to this have had neither prince nor chief among them. Nor will any one of them ever be able, after all their pretences, to prove his deſcent from Aaron, or to ſay with certainty whether he is of the tribe of Judah or of the tribe of Levi, till he ſhall diſcover that unknown country where never mankind dwelt, and where the apocryphal Eſdras has placed their brethren of the ten tribes. This being the caſe, it is impoſſible they can have either an altar, or a ſacrifice, or a prieſthood, according to the inſtitution of Moſes, but are evidently an outcaſt people living under laws which cannot be fulfilled. Prophecy.

25 And the cauſe of it.

The cauſe of this deplorable condition is likewiſe aſſigned with the ſame perſpicuity: They are ſcattered over the face of the earth, becauſe they do not acknowledge Chriſt for the Meſſiah; becauſe they do not ſubmit to their own king, the true David. In the prophetic writings the name of David is frequently given to the Meſſiah, who was to deſcend from that prince. Thus Ezekiel, ſpeaking of the kingdom of Chriſt, ſays, "I will ſet up one Shepherd over them, and he ſhall feed them, even my ſervant David; he ſhall feed them, and he ſhall be their ſhepherd." And Jeremiah ſays, "They ſhall ſerve the Lord their God, and David their king, whom I will raiſe up unto them."

That in theſe places, as well as in the paſſage under conſideration, the Meſſiah is meant, is undeniable; for David the ſon of Jeſſe was dead long before any of the three prophets was born; and by none of them it is ſaid, "afterwards David their king ſhall come again;" but "afterwards the children of Iſrael ſhall *return* to David their king," they ſhall recover from their blind infatuation, and ſeek him whom they have not yet known. By their not receiving Jeſus for the Chriſt, they have forfeited all claim to the divine favour, and are, of conſequence, "without a king, and without a chief, and without a ſacrifice, and without an altar, and without a prieſthood."

26 Their return alſo foretold.

The time, however, will come, when they ſhall return and ſeek "the Lord their God and David their king;" when they ſhall tremble before him whom their fathers crucified, and honour the ſon even as they honour the father. That this part of the prophecy will in time be as completely fulfilled as the other has been, may be confidently expected from the wonderful preſervation of the Jews for ſo many ages. Scattered as they

(B) Such is our tranſlation of this remarkable prophecy; but the Greek verſion of the Seventy has it, perhaps more properly, thus: "The children of Iſrael ſhall abide many days without a king, and without a chief, and without ſacrifice, and without an altar, and without a prieſthood, and without prophecies. Afterwards," &c.

Prophecy. they are over the whole earth, and hated as they are by all nations, it might naturally be thought, that in proceſs of time they would have coaleſced with their conquerors, and have been ultimately abſorbed and annihilated by the union, ſo that not a trace of them ſhould now have remained; yet the fact is, that, diſperſed as they have ever ſince been over the whole face of the globe, they have never, in a ſingle inſtance in any country, loſt their religious or national diſtinctions; and they are now generally ſuppoſed to be as numerous as they were under the reigns of David and Solomon. This is contrary to all hiſtory, and all experience of the courſe of human affairs in ſimilar caſes; it has been boldly and juſtly ſtyled a ſtanding miracle. Within 1000 or 1200 years back, a great variety of extraordinary and important revolutions have taken place among the nations of Europe. In the ſouthern part of this iſland the Britons were conquered by the Saxons, the Saxons by the Danes, and the Danes and Saxons by the Normans; but in a few centuries theſe oppoſite and hoſtile nations were conſolidated into *one* indiſtinguiſhable maſs. Italy, about the ſame time that Britain was ſubdued by the Saxons, was conquered by the Goths and Vandals: and it is not eaſy to conceive a more ſtriking contraſt than that which ſubſiſted between the poliſhed inhabitants of that delightful country and their ſavage invaders; and yet how ſoon did all diſtinction ceaſe between them! In France, the Roman colonies gradually aſſimilated with the ancient Gauls; and in Spain, though the Moors continued for ſeveral ages, and till their final expulſion, a diſtinct people, yet after they were once reduced to a ſtate of ſubjection, their numbers very ſenſibly diminiſhed; and ſuch of them as were ſuffered to remain after their laſt overthrow have been long ſince ſo blended with the Spaniards that they cannot now be diſtinguiſhed. But with regard to the Jews, the wonder is, that though they do not in any country where they are ſettled bear any proportion to the natural inhabitants, though they are univerſally reduced to a ſtate of the loweſt ſubjection, and even expoſed to hatred, contempt, and perſecution; yet in no inſtance does there ſeem to be the leaſt appearance or probability of their numbers being diminiſhed, in no inſtance do they diſcover any decay of attachment to their religious principles. Whence then comes it that this people alone, who, having no form of government or a republic anywhere ſubſiſting, are without the means by which other people are kept united and diſtinct, ſhould ſtill be preſerved amongſt ſo many different nations? How comes it, when they have been thus ſcattered into ſo many diſtant corners, like duſt which cannot be perceived, that they ſhould ſtill ſo long ſurvive the diſſolution of their own ſtate, as well as that of ſo many others? To theſe queſtions the anſwer is obvious: They are preſerved, that, as a nation, "they may return and ſeek the Lord their God and David their king, and fear the Lord and his goodneſs in the latter days."

27 Of prophecies reſpecting the Chriſtian church.

We might here ſubjoin many prophecies both from the Old and the New Teſtament, and eſpecially from the writings of St Paul and St John, which ſo clearly deſcribe the various fortunes of the Chriſtian church, her progreſs to that ſtate of general corruption under which ſhe was ſunk three centuries ago, and her gradual reſtoration to her primitive purity, that they cannot be ſuppoſed to proceed from the cunning craftineſs of men, or to have been written after the events of which they ſpeak. To do juſtice to theſe, however, would require a volume, and many excellent volumes have been written upon them. The reader who wiſhes for ſatisfaction on ſo intereſting a ſubject will do well to conſult the writings of Mr Mede and Sir Iſaac Newton, together with Biſhop Newton's Diſſertations, and the Sermons of Hurd, Halifax, and Bagot, preached at Warburton's lecture. We ſhall only obſerve, that one of the ableſt reaſoners that Great Britain ever produced, after having paid the cloſeſt attention to the predictions of the New Teſtament, hath been bold enough to put the truth of revealed religion itſelf upon the reality of that prophetic ſpirit which foretold the deſolation of Chriſt's church and kingdom by antichriſt. "If (ſays he), IN THE DAYS OF ST PAUL AND ST JOHN, there was any footſtep of ſuch a ſort of power as this in the world; or if there HAD BEEN any ſuch power *in* the world; or if there WAS THEN any appearance or probability that could make it enter into the heart of man to imagine that there EVER COULD BE any ſuch kind of power in the world, much leſs in the *temple* or *church of God;* and if there be not NOW ſuch a power actually and conſpicuouſly exerciſed in the world; and if any picture of this power, DRAWN AFTER THE EVENT, can now deſcribe it more plainly and exactly than it was originally deſcribed in the words of the prophecy—then may it, with ſome degree of plauſibility, be ſuggeſted, that the prophecies are nothing more than enthuſiaſtic imaginations."

Upon the whole, we conclude with Biſhop Sherlock, that the various prophecies recorded in the Holy Scriptures were given, not to enable man to foreſee with clearneſs future events, but to ſupport the ſeveral diſpenſations of religion under which they were reſpectively promulgated. The principal prophecies recorded in the Old Teſtament led mankind to hope for a complete deliverance from the curſe of the fall; and therefore tended to fill their minds with gratitude, and to enforce a cheerful obedience to that God who in the midſt of judgment remembereth mercy. The prophecies, whether in the Old or New Teſtament, that pourtray the preſent ſtate of the Jews, and the various fortunes of the Chriſtian church, as they are daily fulfilling in the preſence of all men, are the ſtrongeſt poſſible proof of the divinity of our holy religion, and ſupply to us in the latter days the place of miracles, by which it was at firſt eſtabliſhed.

Prophecy, Prophet.

PROPHET, in general, a perſon who foretels future events; but is particularly applied to ſuch inſpired perſons among the Jews as were commiſſioned by God to declare his will and purpoſes to that people. Among the canonical books of the Old Teſtament we have the writings of 16 prophets, four of whom are denominated the *greater prophets*, viz. Iſaiah, Jeremiah, Ezekiel, and Daniel; ſo called from the length or extent of their writings, which exceed thoſe of the others, viz. Hoſea, Joel, Amos, Obadiah, Jonah, Micah, Nahum, Habakkuk, Haggai, Zechariah, and Malachi, who are called the *leſſer prophets*, from the ſhortneſs of their writings. The Jews do not place Daniel among the prophets, becauſe, they ſay, he lived the life of a courtier rather than that of a prophet. An account of the ſeveral writings of the prophets may be ſeen each under its particular head. See the article ISAIAH, &c.

Some

Prophet || Proportion.

Sons of the PROPHETS, in ſcripture hiſtory, an appellation given to young men who were educated in the ſchools or colleges under a proper maſter, who was commonly, if not always, an inſpired prophet, in the knowledge of religion and in ſacred muſic, and thus were qualified to be public preachers; which ſeems to have been part of the buſineſs of the prophets on the Sabbath-days and feſtivals. It is probable that God generally choſe the prophets, whom he inſpired, out of theſe ſchools. See PROPHECY.

PROPITIATION, in theology, a ſacrifice offered to God to aſſuage his wrath and render him propitious. Among the Jews there were both ordinary and public ſacrifices, as holocauſts, &c. offered by way of thankſgiving; and extraordinary ones, offered by particular perſons guilty of any crime, by way of propitiation. The Romiſh church believe the maſs to be a ſacrifice of propitiation for the living and the dead. The reformed churches allow of no propitiation but that one offered by Jeſus Chriſt on the croſs. See SACRIFICE.

PROPITIATORY, any thing rendering God propitious; as we ſay *propitiatory* ſacrifices, in contradiſtinction to ſacrifices which were *euchariſtical*. Among the Jews the propitiatory was the cover or lid of the ark of the covenant; which was lined both within and withoutſide with plates of gold, inſomuch that there was no wood to be ſeen. This propitiatory was a type or figure of Chriſt, whom St Paul calls the propitiatory ordained from all ages. See *ARK of the Covenant*.

PROPOLIS, the name of a certain ſubſtance more tenacious than wax, with which the bees ſtop up all the holes or cracks in the ſides of their hives. See BEE, n° 13.

PROPONTIS, or SEA OF MARMORA, a part of the Mediterranean, dividing Europe from Aſia; it has the Helleſpont or canal of the Dardanelles to the ſouth-weſt, whereby it communicates with the Archipelago, and the ancient Boſphorus of Thrace, or Strait of Conſtantinople, to the north-eaſt, communicating with the Black or Euxine Sea. It has two caſtles: that on the Aſia ſide is on a cape, where formerly ſtood a temple of Jupiter. The caſtle of Europe is on an oppoſite cape, and had anciently a temple of Serapis. It is 120 miles long, and in ſome places upwards of 40 miles broad.

PROPORTION, the identity or ſimilitude of two ratios. Hence quantities that have the ſame ratio between them are ſaid to be proportional; *e. gr.* if A be to B as C to D, or 8 be to 4 as 30 to 15; A, B, C, D, and 8, 4, 30, and 15, are ſaid to be in proportion, or are ſimply called proportionals. Proportion is frequently confounded with ratio; yet have the two in reality very different ideas, which ought by all means to be diſtinguiſhed. Ratio is properly that relation or habitude of two things, which determines the quantity of one from the quantity of another, without the intervention of any third: thus we ſay the ratio of 5 and 10 is 2, the ratio of 12 and 24 is 2. Proportion is the ſameneſs or likeneſs of two ſuch relations: thus the relations between 5 and 10 and 12 and 24 being the ſame, or equal, the four terms are ſaid to be in proportion. Hence ratio exiſts between two numbers, but proportion requires at leaſt three. Proportion, in fine, is the habitude or relation of two ratios when compared together; as ratio is of two quantities. See ALGEBRA, ARITHMETIC, and GEOMETRY. Proportion.

Arithmetical and Geometrical PROPORTION. See PROGRESSION.

Harmonical or Muſical PROPORTION, is a kind of numeral proportion formed thus: of three numbers, if the firſt be to the third as the difference of the firſt and ſecond to the difference of the ſecond and third; the three numbers are in harmonical proportion.

Thus 2, 3, 6, are harmonical, becauſe 2 : 6 : : 1 : 3. So alſo four numbers are harmonical, when the firſt is to the fourth as the difference of the firſt and ſecond to the difference of the third and fourth.

Thus 24, 16, 12, 9, are harmonical, becauſe 24 : 9 : : 8 : 3. By continuing the proportional terms in the firſt caſe, there ariſes an harmonical progreſſion or ſeries.

1. If three or four numbers in harmonical proportion be multiplied or divided by the ſame number; the products or quotients will alſo be in harmonical proportion: thus, if 6, 8, 12, which are harmonical, be divided by 2, the quotients 3, 4, 6, are alſo harmonical; and reciprocally their products by 2, viz. 6, 8, 12.

2. To find an harmonical mean between two numbers given; divide double the product of the two numbers by their ſum, the quotient is the mean required; thus ſuppoſe 3 and 6 the extremes, the product of theſe is 18, which doubled gives 36; this divided by 9 (the ſum of 3 and 6) gives the quotient 4. Whence 3, 4, 6, are harmonical.

3. To find a third harmonical proportional to two numbers given.

Call one of them the firſt term, and the other the ſecond: multiply them together, and divide the product by the number remaining after the ſecond is ſubtracted from double the firſt; the quotient is a third harmonical proportional: thus, ſuppoſe the given terms 3, 4, their product 12 divided by 2 (the remainder after 4 is taken from 6, the double of the firſt), the quotient is 6, the harmonical third ſought.

4. To find a fourth harmonical proportion to three terms given: multiply the firſt into the third, and divide the product by the number remaining after the middle or ſecond is ſubtracted from double the firſt; the quotient is a third harmonical proportion; thus ſuppoſing the numbers 9, 12, 16, a fourth will be found by the rule to be 24.

5. If there be four numbers diſpoſed in order, whereof one extreme and the two middle terms are in arithmetical proportion; and the ſame middle terms with the other extreme are in harmonical proportion, the four are in geometrical proportion; as here 2 : 3 : : 4 : 6, which are geometrical; whereof 2, 3, 4, are arithmetical, and 3, 4, 6, harmonical.

6. If betwixt any two numbers you put an arithmetical mean, and alſo an harmonical one, the four will be in geometrical proportion: thus betwixt 2 and 6 an arithmetical mean is 4, and an harmonical one 3; and the four 2 : 3 : : 4 : 6, are geometrical.

We have this notable difference between the three kinds of proportion, arithmetical, harmonical, and geometrical; that from any given number we can raiſe a continued arithmetical ſeries increaſing *in infinitum*, but

Proportion || Proprefect.

not decreasing: the harmonical is decreasable *in infinitum*, but not increasable; the geometrical is both.

PROPORTION, or *Rule of Three*. See ARITHMETIC, n° 13, 14, 15.

Reciprocal PROPORTION. See RECIPROCAL.

PROPORTION is also used for the relation between unequal things of the same kind, whereby their several parts correspond to each other with an equal augmentation or diminution.

Thus, in reducing a figure into little, or in enlarging it, care is taken to observe an equal diminution or enlargement, through all its parts; so that if one line, *e. gr.* be contracted by one-third of its length, all the rest shall be contracted in the same proportion.

PROPORTION, in architecture, denotes the just magnitude of the members of each part of a building, and the relation of the several parts to the whole; *e. gr.* of the dimensions of a column, &c. with regard to the ordonnance of a whole building.

One of the greatest differences among architects, M. Perrault observes, is in the proportions of the heights of entablatures with respect to the thickness of the columns, to which they are always to be accommodated.

In effect, there is scarce any work, either of the ancients or moderns, wherein this proportion is not different; some entablatures are even near twice as high as others:—yet it is certain this proportion ought of all others to be most regulated; none being of greater importance, as there is none wherein a defect is sooner spied, nor any wherein it is more shocking.

Compass of PROPORTION, a name by which the French, and after them some English, authors call the SECTOR.

PROPORTIONAL, relating to proportion. Thus we say, proportional compasses, parts, scales, spirals, &c.

PROPORTIONALS, in geometry, are quantities, either linear or numeral, which bear the same ratio or relation to each other.

PROPOSITION, in logic, part of an argument wherein some quality, either negative or positive, is attributed to a subject.

PROPOSITION, in mathematics, is either some truth advanced and shown to be such by demonstration, or some operation proposed and its solution shown. If the proposition be deduced from several theoretical definitions compared together, it is called a *theorem*; if from a praxis, or series of operations, it is called a *problem*. See the articles THEOREM and PROBLEM.

PROPOSITION, in oratory. See ORATORY, n° 28. 124.

PROPOSITION, in poetry, the first part of a poem, wherein the author proposes briefly, and in general, what he is to say in the body of his work. It should comprehend only the matter of the poem, that is, the action and persons that act. Horace prescribes modesty and simplicity in the proposition, and would not have the poet promise too much, nor raise in the reader too great ideas of what he is going to relate.

PROPREFECT, among the Romans, the prefect's lieutenant, or an officer whom the prefect of the pretorium commissioned to do part of his duty in his place.

Propretor || Prosecution.

PROPRETOR, a Roman magistrate, who, having discharged the office of pretor at home, was sent into a province to command there with his former pretorial authority. It was also an appellation given to those who, without having been pretors at Rome, were sent extraordinarily into the provinces to administer justice with the authority of pretors.

PROPRIETOR, or PROPRIETARY, is he who possesses any thing as his own in the utmost degree. Such monks were called *proprietary* as had reserved goods and effects to themselves, notwithstanding their formal renunciation of all at the time of their profession. They are frequently mentioned in the *Monast. Anglic.* &c. and were to be very severely dealt with; to be excommunicated, deprived of burial, &c. *Monachi proprietarii excommunicentur ab abbatibus: et, si in morte proprietarius inventus fuerit, ecclesiastica careat sepultura*, &c. Addit. ad Matt. Par.

PRO RATA, in commerce, a term sometimes used by merchants for *in proportion;* as each person must reap the profit or sustain the loss, *pro rata* to his interest, that is, in proportion to his stock.

PROROGATION, the act of prolonging, adjourning, or putting off, to another time. The difference between a prorogation and an adjournment of parliament is, that by prorogation the session is ended, and such bills as passed in either house, or both houses, and had not the royal assent, must at the next assembly begin again.

PROSCRIPTION, a publication made in the name of the chief or leader of a party, whereby he promises a reward to any one who shall bring him the head of one of his enemies.

Sylla and Marius by turns proscribed each other's adherents.—Under the triumvirate a great part of the best and bravest of the Romans fell by proscription.

The term took its rise from the practice of writing down a list of the persons names, and posting it in public; from *pro* and *scribo* "I write."

PROSE, the natural language of mankind, loose and unconfined by poetical measures, rhymes, &c. In which sense it stands opposed to verse.

There is, however, a species of prose which is measured, such as that in which epitaphs and other inscriptions are generally written; and indeed every man who has formed for himself a style writes in uniform periods regularly recurring. It has been much disputed whether a poem can be written in prose. We enter not into that dispute, as we have said enough on the subject elsewhere. See NOVEL.

The word *prose* comes from the Latin *prosa*, which some will have derived from the Hebrew *poras*, which signifies *expendit:* others deduce it from the Latin *prorsa*, of *prorsus*, "going forwards;" by way of opposition to *versa*, or "turning backwards," as is necessary in writing.

PROSECUTION, in the criminal law. The next step towards the punishment of offenders after COMMITMENT, is their prosecution, or the manner of their formal accusation. And this, in the English law, is either upon a previous finding of the fact by an inquest or grand jury; or without such previous finding.

The former way is either by PRESENTMENT or INDICTMENT. See these articles.

The

ecutor
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ıflam-
ıene.

The remaining methods of profecution are without any previous finding by a jury, to fix the authoritative ſtamp of veriſimilitude upon the accuſation. One of theſe, by the common law, was when a thief was taken *with the mainour*, that is, with the thing ſtolen upon him, *in manu*. For he might, when ſo detected, *flagrante delicto*, be brought into court, arraigned, and tried, without indictment: as by the Daniſh law he might be taken and hanged upon the ſpot without accuſation or trial. But this proceeding was taken away by ſeveral ſtatutes in the reign of Edward III. though in Scotland a ſimilar proceſs remains to this day. So that the only ſpecies of proceeding at the ſuit of the king, without a previous indictment or preſentment by a grand jury, now ſeems to be that of INFORMATION; which ſee.

Theſe are all the methods of proſecution at the ſuit of the king. There yet remains another, which is merely at the ſuit of the ſubject, and is called an APPEAL. See that article.

But of all the methods of proſecution, that by indictment is the moſt general. See INDICTMENT.

PROSECUTOR, in law, he that purſues a cauſe in another's name.

PROSELYTE, a new convert to ſome religion or religious ſect.

PROSERPINACA, in botany: A genus of the trigynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 15th order, *Inundatæ*. The calyx is tripartite ſuperior; there is no corolla; there is one trilocular ſeed.

PROSERPINE, in fabulous hiſtory, the daughter of Jupiter and Ceres, was carried off by Pluto as ſhe was gathering flowers with her companions. Ceres, diſconſolate for the loſs of her daughter, after having long ſought her, heard where ſhe was, and intreated Jupiter to let her return from hell. This requeſt Jupiter granted, on condition ſhe had taſted nothing in Pluto's dominions. Ceres therefore went to fetch her; but when her daughter was preparing to return, Aſcalaphus gave information that he had ſeen Proſerpine eat ſome grains of a pomegranate ſhe had gathered in Pluto's garden; on which ſhe was ſentenced to continue in Tartarus in quality of Pluto's ſpouſe, and the queen of thoſe gloomy regions: but to mitigate the grief of Ceres for her diſappointment, Jupiter granted that her daughter ſhould only ſpend ſix months together in hell with her huſband, and the other ſix on earth with her mother.

Some mythologiſts imagine that the latter part of the fable alludes to the corn, which muſt remain all the winter hid in the earth, in order to ſprout forth in the ſpring, and produce the harveſt.

PROSEUCHE, in antiquity, properly ſignifies *prayer*; but it is taken for the places of prayer of the Jews, and was pretty near the ſame as their ſynagogues. But the ſynagogues were originally in the cities, and were covered places: whereas, for the moſt part, the proſeuches were out of the cities, and on the banks of rivers; having no covering, except perhaps the ſhade of ſome trees or covered galleries. The word is Greek, προσευχὴ *prayer*.

PROSLAMBANOMENE, the name of a muſical note in the Greek ſyſtem.

As the two tetrachords of the Greeks were conjunctive, or, in other words, as the higheſt note of the firſt ſerved likewiſe for the loweſt note of the ſecond, it is plain that a complete octave could not be formed. To remedy this deficiency, therefore, one note beneath the loweſt tetrachord was added, as an octave to the higheſt of the laſt tetrachord. Thus, if we ſuppoſe the firſt to have begun on B, the laſt muſt have ended upon A, to which one note ſubjoined immediately beneath the loweſt B in the diatonic order muſt have formed an octave. This note was called *proſlambanomene*. But it appears from authors who have ſcrutinized antiquity with ſome diligence, and perhaps with as much ſucceſs as the data upon which they proceeded could produce, that the names of the notes in the Greek ſyſtem, which originally ſignified their natural ſtation in the ſcale of aſcending or deſcending ſounds, were afterwards applied to their poſitions in the lyre. *Higher* or *lower*, then, according to this application, did not ſignify their degrees of acuteneſs or gravity, but their higher or lower ſituation upon this inſtrument. *Burney's Hiſt. of Muſic*, Diſſert. § 1.

Proſody
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Protagoras.

PROSODY, that part of grammar which treats of the quantities and accents of ſyllables, and the manner of making verſes.

The Engliſh proſody turns chiefly on two things, numbers and rhyme. See POETRY, nº 66—76. and Part III.

PROSOPIS, in botany: A genus of the monogynia order, belonging to the decandria claſs of plants. The calyx is hemiſpherical and quadridentate; the ſtigma is ſimple; the legumen inflated and monoſpermous.

PROSOPOPŒIA, a figure in oratory, whereby we raiſe qualities of things inanimate into perſons. See ORATORY, p. 439 and 452.

PROSTATÆ, in anatomy, a gland, generally ſuppoſed to be two ſeparate bodies, though in reality but one, ſituated juſt before the neck of the bladder, and ſurrounding the beginning of the urethra. See ANATOMY, p. 738. col. 2.

PROSTYLE, in architecture, a range of columns in the front of a temple.

PROTAGORAS, a famous Greek philoſopher, was born at Abdera. In his youth, his poverty obliged him to ſubmit to the ſervile office of frequently carrying logs of wood from the neighbouring fields to Abdera. It happened, that as he was one day going on briſkly towards the city under one of theſe loads, he was met by Democritus, who was particularly ſtruck with the neatneſs and regularity of the bundle. Deſiring him to ſtop and reſt himſelf, Democritus examined more cloſely the ſtructure of the load, and found that it was put together with mathematical exactneſs; upon which he aſked the youth whether he himſelf had made it up. Protagoras aſſured him that he had; and immediately taking it to pieces, with great eaſe replaced every log in the ſame exact order as before. Democritus expreſſed much admiration of his ingenuity; and ſaid to him, "Young man, follow me, and your talents ſhall be employed upon greater and better things." The youth conſented, and Democritus took him home, maintained him at his own expence, and taught him philoſophy, which qualified him for the office of legiſlator of the Thurians. He was more ſubtle than ſolid in his reaſonings; however, he taught at Athens with great reputation, but was at length *Enfield's Hiſtory of Philoſophy*, Vol. I.

Protaſis || Protector.

length baniſhed from thence for the impiety of his doctrines. He then travelled, and viſited the iſlands in the Mediterranean, where it is ſaid that he was the firſt philoſopher who taught for money. He died in a voyage to Sicily, in a very advanced age. He commonly reaſoned by dilemmas, and left the mind in ſuſpenſe with reſpect to all the queſtions he propoſed. His moral principles were adopted by Hobbes. (See MORAL PHILOSOPHY). Plato wrote a dialogue againſt him. He flouriſhed 400 years B. C.

PROTASIS, in the ancient drama, the firſt part of a comic or tragic piece, wherein the ſeveral perſons are ſhown, their characters intimated, and the ſubject of the piece propoſed and entered upon.

It might reach as far as our two firſt acts; and where it ended the epitaſis commenced. See the article EPITASIS.

PROTEA, the SILVER-TREE: A genus of the monogynia order, belonging to the tetrandria claſs of plants; and in the natural method ranking under the 47th order, *Stellatæ*. There is one quadrifid petal ſurrounding the germ; there is no proper calyx; the receptacle is paleaceous. There are 36 ſpecies, all natives of the Cape of Good Hope; of which the moſt remarkable are, 1. The conifera, with linear, ſpear-ſhaped, entire leaves, grows to the height of 10 or 12 feet, with a ſtraight regular ſtem. The branches naturally form a large regular head. The leaves are long and narrow, of a ſhining ſilver colour; and as they remain the whole year, make a fine appearance in the greenhouſe. 2. The argentea, commonly called *ſilver-tree*, has a ſtrong upright ſtem covered with purpliſh bark, dividing into ſeveral branches which grow erect, garniſhed with broad, ſhining, ſilvery leaves, which make a fine appearance when intermixed with other exotics. Through the whole year it exhibits its gloſſy white or ſilvery leaves. It has at firſt a very uncommon and beautiful appearance, and ſometimes in the courſe of 12 or 15 years reaches the height of 20 feet, which it never exceeds. In a rich ſoil it grows twice as quick, and is by far the largeſt of the protea kind. They are generally planted near ſome farms, and very ſeldom grow wild; Mr Sparman * thinks it was probably brought to the Cape of Good Hope from *Anamaqua*; for he had travelled over the whole north-eaſt ſide of Hottentot's Holland, without finding it either in its wild ſtate or planted. 3. The nitida, or wageboom, greatly reſembles the ſecond ſort: the leaves are very ſilky and white, with erect purple branches.

* *Voyage to the Cape of Good Hope*, Vol. I. P. 33.

All theſe plants, being tender exotics, require to be continually kept in the greenhouſe during winter. The firſt may be propagated by cuttings, which ſhould be cut off in April, juſt before the plants begin to ſhoot; the ſecond and third ſorts may be propagated by ſeeds.

PROTECTOR, a perſon who undertakes to ſhelter and defend the weak, helpleſs, and diſtreſſed.

Every Catholic nation, and every religious order, has a protector reſiding at the court of Rome, who is a cardinal, and is called the *cardinal protector*.

Protector is alſo ſometimes uſed for a regent of a kingdom, made choice of to govern it during the minority of a prince.

Cromwell aſſumed the title and quality of *lord protector of the commonwealth of England*, &c.

PROTESILAI TURRIS, the ſepulchre of Proteſilaus, with a temple, at which Alexander ſacrificed, (Arian); ſituated at the ſouth extremity of the Helleſpont, next the Cherſoneſus Thracia. Proteſilaus was the firſt Greek who landed on the coaſt of Troy, and the firſt Greek ſlain by the Trojans, (Homer, Ovid.) His wife Laodamia, to aſſuage her grief, begged the gods for a ſight of his ſhade; and obtaining her requeſt, ſhe expired in his embraces, (Hyginus.) Proteſilaus was alſo called *Phylacides*, from Phylace, a town of Theſſaly.

Proteſ. || Prote.

PROTEST, in law, is a call of witneſs, or an open affirmation that a perſon does, either not at all, or but conditionally, yield his conſent to any act, or to the proceeding of any judge in a court in which his juriſdiction is doubtful, or to anſwer upon his oath farther than he is bound by law.

Any of the lords in parliament have a right to proteſt their diſſent to any bill paſſed by a majority: which proteſt is entered in form. This is ſaid to be a very ancient privilege. The commons have no right to proteſt. See PARLIAMENT.

PROTEST, in commerce, a ſummons written by a notary-public to a merchant, banker, or the like, to accept or diſcharge a bill of exchange drawn on him, after his having refuſed either to accept or pay it. See *BILL of Exchange*.

PROTESTANT, a name firſt given in Germany to thoſe who adhered to the doctrine of Luther; becauſe in 1529 they proteſted againſt a decree of the Emperor Charles V. and the diet of Spires; declaring that they appealed to a general council. The ſame name has alſo been given to thoſe of the ſentiments of Calvin; and is now become a common denomination for all thoſe of the reformed churches.

PROTEUS, in heathen mythology. See EGYPT, n° 6.

PROTHONOTARY, a term which properly ſignifies *firſt notary*, and which was anciently the title of the principal notaries of the emperors of Conſtantinople.

Prothonotary, with us, is uſed for an officer in the court of king's-bench and common-pleas; the former of which courts has one, and the latter three. The prothonotary of the king's-bench records all civil actions ſued in that court, as the clerk of the crown-office does all criminal cauſes. The prothonotaries of the common pleas enter and enrol all declarations, pleadings, aſſizes, judgments, and actions: they alſo make out all judicial writs, except writs of *habeas corpus*, and *diſtringas jurator*, for which there is a particular office, called the *habeas corpora office*: they likewiſe enter recognizances acknowledged, and all common recoveries; make exemplifications of records, &c.

In the court of Rome there is a college of 12 prelates, called *apoſtolical prothonotaries*, empowered to receive the laſt wills of cardinals, to make all informations and proceedings neceſſary for the canonization of ſaints, and all ſuch acts as are of great conſequence to the Papacy: for which purpoſe they have the right of admiſſion into all conſiſtories, whether public or half public. They alſo attend on the pope, whenever he performs any extraordinary ceremony out of Rome.

PROTO, a Greek term, frequently uſed in compoſition of priority: thus, proto-collum, in the ancient juriſprudence,

togenes
tractor.

jurisprudence, signifies the first leaf of a book; proto-martyr, the first martyr; proto-plast, the first man formed, &c.

PROTOGENES, a celebrated ancient painter, was born at Caunas, a city of Caria, subject to the Rhodians, and flourished 300 years before the birth of our Saviour. He was at first obliged to paint ships for his livelihood; but afterwards acquired the highest reputation for history-painting; though Apelles blamed him for finishing his pieces too highly, and not knowing when to have done. The finest of his pictures was that of Jalisus, which is mentioned by several ancient authors, though none of them give any description of it. He worked seven years on this picture; during which time he lived entirely upon lupines and water, being of opinion that this light and simple nourishment left him greater freedom of fancy. Apelles, on seeing this picture, was struck with such admiration, that he was unable to speak, or to find words sufficient to express his idea of its beauty. It was this picture that saved the city of Rhodes when besieged by Demetrius king of Macedon; for being able to attack it only on that side where Protogenes worked, which he intended to burn, he chose rather to abandon his design than to destroy so fine a piece. Pliny says, that Apelles asking him what price he had for his pictures, and Protogenes naming an inconsiderable sum, Apelles, concerned at the injustice done to the beauty of his productions, gave him 50 talents, about 10,000 l. for one picture only, declaring publicly that he would sell it for his own. This generosity made the Rhodians sensible of the merit of Protogenes; and they were so eager to purchase the picture Apelles had bought, that they paid him a much greater price for it than he had given.

PROTOTYPE, is the original or model after which a thing was formed; but chiefly used for the patterns of things to be engraved, cast, &c.

PROTRACTOR, an instrument for laying down and measuring angles upon paper with accuracy and dispatch; and by which the use of the line of chords is superseded. This instrument is variously formed, as semicircular, rectangular, or circular; and constructed of different materials, as brass, ivory, &c. It is necessary in laying down those surveys or other plans where angles are concerned. For the semicircular protractor, and its use in laying down and measuring angles, see GEOMETRY, p. 676. prop. xx. &c.

The rectangular protractor is constructed in form of a right-angled parallelogram, which, when applied to a case of mathematical instruments, is substituted in place of the semicircular protractor and scale of equal parts. Fig. 1. is a representation of it: the manner of using it is exactly similar to that of the semicircular one.

Plate CCXVIII.

The circular protractor, as its name implies, is a complete circle, and is superior by far to either of the former, both in point of accuracy and dispatch, especially when several angles are to be formed at the same point. The limb of this instrument is divided into 360 degrees, and each degree in some protractors is halved: it has a subdividing scale or vernier, by which an angle may be laid down or measured to a single minute. In the centre of the protractor is a fine mark, which, when an angle is to be protracted or measured, is to be laid upon the angular point, and 0, or zero on the limb, upon the given line forming one side of the angle. Protractor.

Fig. 2. represents a circular protractor whose limb is divided as above described, and the dividing scale on the index, which moves round the limb of the protractor on a conical centre, gives every minute of a degree. That part of the index beyond the limb has a steel point fixed at the end, in a direct line with the centre of the protractor, and whose use is to prick off the proposed angles.

Fig. 3. is another circular protractor, a little differently constructed from the former. The central point is formed by the intersection of two lines crossing each other at right angles, which are cut on a piece of glass. The limb is divided into degrees and half degrees, having an index with a vernier graduated to count to a single minute, and is furnished with a tooth and pinion, by means of which the index is moved round by turning a small nut. It has two pointers, one at each end of the index, furnished with springs for keeping them suspended while they are bringing to any angle; and being brought, applying a finger to the top of the pointer, and pressing it down, pricks off the angle. There is this advantage in having two pointers, that all the bearings round a circuit may be laid or pricked off, although the index traverses but one half of the protractor.

Another circular protractor, different from either of the former, is represented at fig. 4. The centre is also formed by the intersection of two lines at right angles to each other, which are cut on glass, that all parallax may thereby be avoided. The index is moved round by a tooth and pinion. The limb is divided into degrees and half degrees, and subdivided to every minute by the vernier. The pointer may be set at any convenient distance from the centre, as the socket which carries it moves upon the bar BC, and is fixed thereto by the nut D, at right angles to the bar BC, and moveable with it. There is another bar EF: On this bar different scales of equal parts are placed; so that by moving a square against the inner edge thereof, angles may be transferred to any distance within the limits, from the centre containing the same number of degrees marked out by the index.

It would indeed be superfluous to describe any more of these circular protractors, especially as the little alterations in them depend very much upon the fancy of the artist. Suffice it however to say, that we have seen others still differently constructed, one of which we shall briefly describe. The divisions upon the limb of this instrument are similar to those already described; but the index is a straight bar continued to some considerable distance each way beyond the limb of the instrument, and has a vernier to show minutes as usual; a mark upon one of the edges of the index always coincides with the centre of the instrument. Instead, therefore, of pricking down the angle as in the former, part of the line containing the angle may be drawn, which, although perhaps not so accurate as a point, is more conspicuous, and the line is easily completed upon removal of the protractor. The common dimensions of the circular part of these instruments is from six to ten inches diameter; and they are made of brass.

PROTUBERANCE,

Protuberance ‖ Providence

PROTUBERANCE, in anatomy, is any eminence, whether natural or preternatural, that projects or advances out beyond the reſt.

PROVEDITOR, an officer in ſeveral parts of Italy, particularly at Venice, who has the direction of matters relating to policy.

PROVENCE, a province or government of France, bounded by Dauphine on the north, by Piedmont on the eaſt, by the Mediterranean on the ſouth, and by the river Rhone, which ſeparates it from Languedoc, on the weſt: it is about 100 miles long, and near as many broad.

PROVEND, or PROVENDER, originally ſignified a kind of veſſel containing the meaſure of corn daily given to a horſe, or other beaſt of labour, for his ſubſiſtence; but is now generally uſed to ſignify the food for cattle, whatever it is.

PROVERB, according to Camden, is a conciſe, witty, and wiſe ſpeech, grounded upon experience, and for the moſt part containing ſome uſeful inſtruction.

Book of PROVERBS, a canonical book of the Old Teſtament, containing a part of the proverbs of Solomon the ſon of David king of Iſrael. The firſt 24 chapters are acknowledged to be the genuine work of that prince; the next five chapters are a collection of ſeveral of his proverbs made by order of king Hezekiah; and the two laſt ſeem to have been added, though belonging to different and unknown authors, Agur the ſon of Jakeh, and king Lemuel.

In this excellent book are contained rules for the conduct of all conditions of life; for kings, courtiers, maſters, ſervants, fathers, mothers, children, &c.

1 Definition. PROVIDENCE, the ſuperintendence and care which God exerciſes over creation.

2 Belief of a providence univerſal. That there exiſts a divine providence which attends to the affairs of this world, and directs their courſe, has been a received opinion among the human race in every country and in every period of hiſtory. Every altar that is erected, every prayer and every ſacrifice that is offered up, affords a proof of this belief. So fully have men been convinced of the ſincerity of each other's faith upon this ſubject, that in one form, that of an appeal to the Divine Ruler of the world, by the ſolemnity of an oath, they have introduced it both into the moſt ordinary and the moſt important buſineſs of life.

3 Exiſtence of providence may be proved on ſcientific principles. This univerſal conviction of men of all degrees of knowledge, from the moſt profound philoſopher to the rudeſt barbarian, is probably to be traced to ſome primæval tradition, never totally effaced from any nation under heaven. The truth itſelf, however, is ſuſceptible of the moſt complete proof from principles of ſcience. If the world had a beginning, it may obviouſly have an end, and can be continued in exiſtence only by the conſtant energy of that power by which it was at firſt created. He therefore who acknowledges a creation and denies a providence, involves himſelf in this palpable contradiction—"that a ſyſtem, which of itſelf had not an original and momentary exiſtence, may yet of itſelf have a perpetual exiſtence; or that a being which cannot of itſelf exiſt for a ſecond of time, may yet, of itſelf, exiſt for thouſands of years!" Or ſhould we be ſo complaiſant, as for a moment to ſuppoſe, with certain theiſts, ancient and modern, that the *matter* of the univerſe is ſelf-exiſtent and eternal, and that the power of God was exerted, not in creating ſubſtances, but in reducing the original matter from a ſtate of chaos into that beautiful order in which we ſee it arranged; the conſtant energy of providence muſt ſtill be admitted as neceſſary to preſerve the forms and to continue the motions which were originally impreſſed upon the chaotic maſs. From late experiments it appears extremely doubtful whether any two atoms of the moſt ſolid body be in actual contact; and that they are not *all* in contact is certain. (See METAPHYSICS, n° 176. and OPTICS, n° 46, 64, 66.) Yet it requires a very conſiderable degree of force to carry to a greater diſtance from one another the parts of a ſtone or of a bar of iron. By what power then are theſe parts kept contiguous? It cannot be by their own; becauſe nothing can act where it is not preſent, and becauſe our beſt philoſophy has long taught us that the atoms of matter are eſſentially inactive. Again, it requires a very great degree of force to bring two bodies, however ſmall, into *apparent* contact (ſee OPTICS, *ubi ſupra*); and therefore it follows that they muſt be kept aſunder by ſome foreign power. Every attempt to ſolve theſe phenomena by the intervention of a ſubtle fluid is vain; for the queſtion recurs, what keeps the parts of the fluid itſelf contiguous, and yet ſeparated from each other? Providence.

The coheſion therefore of the parts of matter, and that which is called their repulſive power, demonſtrate, through the whole ſyſtem, the immediate energy of ſomething which is not matter, and by which every body ſmall and great is preſerved in its proper form. It has been elſewhere ſhown (ſee METAPHYSICS, Part II. chap. 5. and MOTION, n° 19, 20.), that the various motions which are regularly carried on through the univerſe, by which animals and vegetables grow and decay, and by which we have day and night, ſummer and winter, cannot be accounted for by any laws of mere mechaniſm, but neceſſarily imply the conſtant agency of ſomething which is itſelf diſtinct from matter. But the forms of bodies are preſerved, and their natural motions carried on, for purpoſes obviouſly planned by Wiſdom. The power therefore which effects theſe things muſt be combined with intelligence: but power and intelligence preſerving the order of the univerſe conſtitute all that is meant by a general providence; which is therefore as certainly adminiſtered as the ſun daily riſes and ſets, or as bodies are kept ſolid by what is termed coheſion and repulſion.

4 Reaſoning of the Bramins of Hindoſtan. Abſtracted and metaphyſical as this reaſoning may appear, it is by no means peculiar to the philoſophers of Europe. Its force has been felt from time immemorial by the Bramins of Hindoſtan, who, as Sir William Jones informs us*, "being unable to form a diſtinct idea of brute matter independent of mind, or to conceive that the work of ſupreme goodneſs was left a moment to itſelf, imagine that the Deity is ever preſent to his work, not in ſubſtance but in ſpirit and in energy." On this rational and ſublime conception they have indeed built numberleſs abſurd ſuperſtitions; but their holding the opinion itſelf, ſhows that they believe in the reality of providence upon philoſophical principles: and what truth is there on which the mind of man has not ingrafted marks of its own weakneſs?

* *Aſiatic Reſearches*, Vol. I.

Few nations, however, except the ancient Greeks, have had philoſophers equally ſubtile with the Bramins

Providence

of India; and therefore though all mankind have in general agreed in the belief of a ſuperintending Providence, they have in different ages and countries admitted that truth upon different kinds of evidence, and formed very different notions concerning the mode in which the Divine ſuperintendence is exerted.

5 Idea of providence in rude ages.

While ſocieties are ſtill in a rude and unpoliſhed ſtate, while individuals poſſeſs little ſecurity and little leiſure for the exertion of their rational powers, every important or ſingular appearance in nature becomes an object of wonder or of terror. In this ſtate of ignorance, men ſee not the univerſe as it is, a great collection of connected parts, all contributing to form one grand and beautiful ſyſtem. Every appearance ſeems to ſtand alone; they know that it muſt have a cauſe, but what that cauſe is they are ignorant. The phenomena exhibited by nature are ſo complicated and ſo various, that it never occurs to them that it is poſſible for one Being to govern the whole. Hence aroſe the different ſyſtems of polytheiſm that have appeared in the world. Nature was divided into different regions, and a particular inviſible power was aſſigned to each department: one conducted the flaming chariot of the ſun, another wielded the terrible thunderbolt, and others were employed in diffuſing plenty, and introducing the uſeful arts among men. Thus, although the various ſyſtems of polytheiſm in general acknowledged one Supreme Ruler, the father of gods and men, yet they at the ſame time peopled not only the regions above, the air and the heavens, but they alſo filled the ocean and the land, every grove, and every mountain, with active but inviſible natures. Having ariſen from the ſame cauſes, theſe ſyſtems of polytheiſm, which are ſo many hypotheſes concerning Divine providence, are all extremely ſimilar; and we have a very favourable ſpecimen of them in the elegant mythology of Greece and Rome, which gave to every region of nature a guardian genius, and taught men in the deep receſſes of the foreſt, or in the windings of the majeſtic flood, to expect the preſence of protecting and friendly powers. See POLYTHEISM.

6 The doctrine has had opponents in almoſt every age.

Notwithſtanding this univerſal reception, in ſome form or other, of the doctrine of a divine providence, it has in every age met with ſome opponents. The moſt ancient of theſe were Democritus and Leucippus. They denied the exiſtence of a Deity—aſſerted that all things were mechanically neceſſary, and that thought and ſenſe were only modifications of matter. This is atheiſm in the ſtricteſt ſenſe, and the only form of it that has ever been conſiſtently ſupported. Epicurus followed upon the ſame principles; but he rendered the ſyſtem altogether abſurd, by confeſſing the freedom of the human will. To avoid the imputation of atheiſm, he aſſerted the exiſtence of God; but declared that he reſided above the heavens, and interfered not in human affairs. One of his maxims was, that "the bleſſed and immortal Being neither hath any employment himſelf, nor troubles himſelf with others." Maximus Tyrius * juſtly obſerves, that this is rather a deſcription of a Sardanapalus than of a Deity. And ſome of the moraliſts † of antiquity remarked, that they knew many men among themſelves poſſeſſed of active and generous minds, whoſe characters they valued more highly than that of Epicurus's god. Some of the ancients alſo appear to have entertained the following ſtrange notion: They acknowledged the exiſtence of a Supreme and of many inferior deities; but at the ſame time, they ſuppoſed that there is a certain fate which rules over all, and is ſuperior to the gods themſelves. See *NECESSITY* in Mythology.

Providence

The providence exerted by the Author of nature over his works is uſually divided into two branches: a *general*, referring to the management of the univerſe at large; and a *particular* providence, chiefly regarding particular men.

7 General providence,

Upon the firſt of theſe, in *The Religion of Nature delineated*, the queſtion is ſtated ſomewhat in the following manner: The world may be ſaid to be governed, or at leaſt cannot be ſaid to fluctuate fortuitouſly, if there are laws or rules by which natural cauſes act; if the ſeveral phenomena in it ſucceed regularly, and in general the conſtitution of things is preſerved; if there are rules obſerved in the production of herbs, trees, and the like; if the ſeveral kinds of animals are furniſhed with faculties proper to determine their actions in the different ſtations which they hold in the general economy of the world; and, laſtly, if rational beings are taken care of in ſuch a manner as will at laſt agree beſt with reaſon. By the providence of God we ought to underſtand his governing the world by *ſuch* laws as theſe now mentioned: ſo that if there are ſuch, there muſt be a Divine providence.

8 As it reſpects inanimate objects,

With regard to *inanimate objects*, the caſe agrees preciſely with the above ſuppoſition. The whole of that univerſe which we ſee around us is one magnificent and well regulated machine. The world that we inhabit is a large globe, which, conducted by an inviſible power, flies with a rapidity of which we have no conception, through an extent of ſpace which ſets at defiance every power of fancy to embody it into any diſtinct image. A large flaming orb ſtands immoveable in the heavens; around which this, and other worlds of different magnitudes, perform their perpetual revolutions. Hence ariſe the expected returns of day and night, and the regular diverſity of ſeaſons. Upon theſe great operations a thouſand other circumſtances depend. Hence, for example, the vapours aſcend from the ocean, meet above in clouds, and after being condenſed, deſcend in ſhowers to cover the earth with fertility and beauty. And theſe appearances are permanent and regular. During every age ſince men have been placed upon the earth, this aſtoniſhing machine continued ſteadily to perform its complicated operations. Nothing is left to chance. The ſmalleſt bodies are not leſs regular than the largeſt, and obſerve continually the ſame rules of attraction, repulſion, &c. The apparent variations of nature proceed only from different circumſtances and combinations of things, acting all the while under their ancient laws. We ourſelves can calculate the effects of the laws of gravitation and of motion. We can render them ſubſervient to our own purpoſes, with entire certainty of ſucceſs if we only adhere to the rules eſtabliſhed by nature, that is to ſay, by providence.

9 Vegetables,

Vegetables alſo live and flouriſh according to preſcribed methods. Each ſort is produced from its proper ſeed; has the ſame texture of fibres, is at all times nouriſhed by the *ſame* kind of juices, digeſted and prepared by the *ſame* veſſels. Trees and ſhrubs receive annually their peculiar liveries, and bear their proper fruits: ſo regular are they in this laſt reſpect, that every ſpecies may be ſaid to have its profeſſion or trade appointed

* *Max. Tyr. Diſſert.* 29.
† *Cicero de finibus*, lib. 1. and *De Natura Deorum*, lib. 2.

Providence

pointed to it, by which it furniſhes a certain portion of manufacture, or of food, to ſupply the wants of animals: being created for the purpoſe of conſumption, all vegetables produce great quantities of ſeed to ſupply the neceſſary waſte. Here too, then, there is evidently a *regulation* by which the ſeveral orders are preſerved, and the ends of them anſwered according to their firſt eſtabliſhment.

10 Animals,

With regard to *animals*, they too, in ſtructure of their form, are ſubject to laws ſimilar to thoſe which govern the vegetable world. In the ſentient part of their conſtitution they are no leſs ſubject to rule. The lion is always fierce, the fox is crafty, and the hare is timid. Every ſpecies retains from age to age its appointed place and character in the great family of nature. The various tribes are made and placed in ſuch a manner as to find proper means of ſupport and defence. Beaſts, birds, fiſhes, and inſects, are all poſſeſſed of organs and faculties adapted to their reſpective circumſtances, and opportunities of finding their proper food and prey.

11 And man.

Man is ſubject to the ordinary laws which other material and animal ſubſtances obey; but he is left more at large in the determination of his actions. Yet even here things do not fluctuate at random. Individuals do indeed riſe and periſh according to fixed rules, and nations themſelves have only a temporary endurance. But the ſpecies advances with a ſteady progreſs to intellectual improvement. This progreſs is often interrupted; but it appears not to be leſs ſure at the long-run than even the mechanical laws which govern the material part of our conſtitution. Amidſt the convulſion of ſtates and the ruin of empires, the uſeful arts, when once invented, are never loſt. Theſe, in better times, render ſubſiſtence eaſy, and give leiſure for reflection and ſtudy to a greater number of individuals. Tyre and Sidon have paſſed away, Athens itſelf has become the prey of barbarians, and the proſperity of ancient Egypt is departed, perhaps for ever; but the ſhip, the plow, and the loom, remain, and have been perpetually improving. Thus every new convulſion of ſociety does leſs miſchief than the laſt; and it is hoped that by the aſſiſtance of printing the moſt poliſhed arts and the moſt refined ſpeculations have now become immortal.

The world is not then left in a ſtate of confuſion: it is reduced into order, and methodiſed for ages to come; the ſeveral ſpecies of beings having their offices and provinces aſſigned them. Plants, animals, men, and nations, are in a ſtate of continual change; but ſucceſſors are appointed to relieve them, and to carry on the *ſcheme of Providence*.

12 Difficulty of accounting for particular providence.

But the great difficulty is, how to account for that providence which is called *particular*: For rational beings, and free agents, are capable of doing and deſerving well or ill; and the ſafety or danger, that happineſs or unhappineſs, of a man here, muſt depend upon many things that ſeem ſcarcely *capable* of being determined by Providence. Beſides *himſelf* and his own conduct, he depends upon the conduct of *other men*; whoſe actions, as we naturally ſuppoſe, cannot, conſiſtently with their free will, be controuled for the advantage of another individual. The actions of numbers of men proceeding upon their private freedom, with different degrees of ability, as they croſs and impede, or directly oppoſe each other, muſt produce very different effects upon men of different characters, and thus in a ſtrange manner embarraſs and entangle the general plan. And as to the *courſe of nature*, it may juſtly be aſked, is the force of gravitation to be ſuſpended till a good man paſs by an infirm building? (See PRAYER) Add to this, that ſome circumſtances appear abſolutely irreconcileable. The wind which carries one into port drives another back to ſea; and the rains that are juſt ſufficient upon the hills may drown the inhabitants of the valleys. In ſhort, may we expect *miracles?* or can there be a particular Providence that foreſees and prepares for the ſeveral caſes of individuals, without force frequently committed upon the laws of nature and the freedom of intelligent agents?

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13 No good argument againſt its exiſtence.

In whatever way it is brought about, there is little doubt that ſomething of this kind *muſt* take place. For as the Deity *does* direct, as already mentioned, the great and general progreſs of things in this world, he muſt alſo manage thoſe of leſs importance. Nations are compoſed of individuals. The progreſs of individuals is the progreſs of the nation, and the greateſt events uſually depend upon the hiſtory and the moſt trifling actions of private perſons. The difficulty is to conceive how the ſuperintendence and management of all this can be brought about. But as the ways and the thoughts of the Omnipotent Spirit, whoſe influence pervades, and rules, and animates nature, reſemble not the limited operations of men, we can only form conjectures concerning the means by which his government is conducted.

14 The Deity may eaſily foreſee the actions of men;

1. In the firſt place, then, it is not impoſſible that the Deity ſhould foreſee the future actions of intelligent beings. Many of theſe actions depend upon the mechaniſm of the material world, which was formed by himſelf, and muſt be entirely known to him. Many men among ourſelves poſſeſs much ſagacity in diſcerning the future actions of others, from attending to their known characters, and the circumſtances in which they are placed. If ſuperior natures do exiſt, and minds more perfect than the human, they muſt poſſeſs this penetration in a more eminent degree in proportion to the excellence of their intellectual powers. But if this diſcernment be in God proportionable to his nature, as in lower beings it is proportionable to theirs, it then becomes altogether unlimited, and the future actions of free agents are at once unlocked and expoſed to his view. Add to this, that the Author of nature is well acquainted with the creatures that he has made; he knows the mechaniſm of our bodies, the nature and extent of our underſtandings, and all the circumſtances by which we are ſurrounded. With all theſe advantages, it is making no great ſtretch to ſuppoſe him capable of diſcerning the line of conduct which we will purſue; and this even ſetting aſide the infinity of his nature, to which a thouſand years are as one day, and ſuppoſing him to reaſon from probabilities in the imperfect manner that we do.

15 And may thence fit them for their ſituations in life.

2. There is no impoſſibility at leaſt, that men, whoſe characters and actions are thus foreknown, may be introduced into the world in ſuch times and places as that their acts and behaviour may not only coincide with the general plan of things, but may alſo anſwer many private caſes. The celeſtial bodies are ſo placed that their jarring attractions make out a ſplendid ſyſtem.

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Why then may there not be in the Divine mind ſomething like a projection of the future hiſtory of mankind, as well as of the motions of the heavenly bodies? And why ſhould it not be thought poſſible for men, as well as for them, by ſome ſecret law, or rather by the management of an unſeen power, to be brought into their places in ſuch a manner as that, by the free uſe of their faculties, the conjunctions and oppoſitions of their intereſts and inclinations, the natural influence of their different degrees of talents, power, and wealth, they may conſpire to make out the great ſcheme of human affairs? There is no abſurdity in this ſuppoſition: it is not beyond the power of an almighty and perfect Being; and it is worthy of him. Let us take from the Jewiſh hiſtory, as moſt generally known, an example of what may be ſuppoſed to happen daily. It was the intention of providence to place David the ſon of Jeſſe upon the throne of the Hebrews. The country is invaded by a foreign enemy: the hoſtile armies meet, and lie encamped upon oppoſite mountains. A man comes forth from the army of the invaders, as was extremely common in thoſe times, and defies the Hebrew hoſt to ſend forth a champion to meet him in ſingle combat. Terrified by the gigantic bulk and mighty force of Goliah, no man would riſk the unequal conflict. David, who was too young to carry arms, had been ſent to the camp with proviſions for his brothers, and heard the challenge. In defence of his flock he had killed ſome beaſts of prey in the wilderneſs, and he was an excellent markſman with the ſling. He thought it might probably be as eaſy to kill a man as a wild beaſt; at all events, he knew that a ſtone well directed would prove no leſs fatal to a giant than to a dwarf: he therefore reſolved to try his ſkill; and he tried it with ſucceſs. Here no man's free will was interrupted, and no miracle was accompliſhed: Yet by this *train* of circumſtances thus *brought* together, a foundation was laid for the future fortunes of the ſon of Jeſſe, for the greatneſs of his country, and for accompliſhing the purpoſes of Providence. According to Seneca, "Hoc dico, fulmina non mitti a Jove, ſed ſic omnia diſpoſita, ut ea etiam quæ ab illo non fiunt, tamen ſine ratione non fiunt: quæ illius eſt.—Nam etſi Jupiter illa nunc non facit, fecet ut fierent."—*I ſay, that the lightning comes not directly from the hand of Jove, but things are properly diſpoſed for the indirect execution of his will; for he acts not immediately, but by the intervention of means.*

16 The poſſibility of this exemplified.

17 Secret influences on the mind are far from impoſſible.

3. Laſtly, it is *not impoſſible* that many things may be accompliſhed by ſecret influence, upon the human mind, either by the Deity himſelf, or by the intervention of agents poſſeſſed of powers ſuperior to thoſe which belong to us. "For inſtance, if the caſe ſhould require that a particular man be delivered from ſome threatening *ruin*, or from ſome *misfortune*, which would certainly befal him if he ſhould go ſuch a way at ſuch a time, as he intended: upon this occaſion ſome *new* reaſons may be preſented to his mind why he ſhould not go *at all*, or not *then*, or not *by that road*; or he may forget to go. Or, if he is to be delivered from ſome dangerous *enemy*, either ſome new turn given to his thoughts may divert him from going where the *enemy* will be, or the enemy may be after the ſame manner diverted from coming where *he* ſhall be, or his reſentment may be *qualified*; or ſome proper method of *defence* may be ſuggeſted to the perſon in danger. After the ſame manner advantages and ſucceſſes may be conferred on the deſerving; as, on the other ſide, men, by way of puniſhment for their crimes, may incur miſchiefs and calamities. Theſe things, and ſuch as theſe (ſays Mr Wollaſton *), *may be*. For ſince the motions and actions of men, which depend upon their wills, do alſo depend upon their judgments, as theſe again do upon the *preſent appearances* of things in their minds; if a new proſpect of things can be any way produced, the lights by which they are ſeen *altered*, new forces and directions impreſſed upon the ſpirits, paſſions *exalted* or *abated*, the power of judging *enlivened* or *debilitated*, or the attention taken off without any ſuſpenſion or alteration of the ſtanding laws of nature,—then, without that, *new* volitions, deſigns, meaſures, or a ceſſation of thinking, may alſo be produced; and thus many things prevented that otherwiſe would *be*, and many brought about that would *not*. That there may poſſibly be ſuch inſpirations of new thoughts and counſels (continues our author), may perhaps appear farther from this, that we frequently find thoughts ariſing in our heads, into which we are led by no diſcourſe, nothing we read, no clue of reaſoning, but they ſurpriſe and come upon us from we know not what quarter. If they proceeded from the mobility of ſpirits ſtraggling out of order, and fortuitous affections of the brain, or were they of the nature of *dreams*, why are they not as wild, incoherent, and extravagant as they are?" Is it not much more reaſonable to imagine that they come by the order and direction of an all-ſeeing and all-gracious God, who continually watches over us, and diſpoſes every thing in and about us for the good of ourſelves or others? not to ſpeak of the agreeableneſs of this notion to the opinions of the beſt and wiſeſt men in all ages (A). "If this, then, be the caſe, as it ſeems to be, that mens minds are ſuſceptible of ſuch *inſinuations* and *impreſſions*, as frequently, by ways unknown, do affect them, and give them an inclination towards this or that; how many things (aſks our author) may be brought to paſs by theſe means without *fixing* and *refixing* the laws of nature, any more than they are unfixed when one man alters the opinion of another by throwing in his way a book proper for that purpoſe?"

* *Religion of Nature delineated*, ſect. 5.

18 And may be effected by beings ſuperior to us, or by the Deity.

All this may be effected either by the immediate interpoſition of God himſelf, or by that of beings *inviſible*, and in nature ſuperior to us, who act as the miniſters of his providence. That there are ſuch beings we can hardly doubt, as it is in the higheſt degree improbable that ſuch imperfect beings as men are at the top of the ſcale of created exiſtence. And ſince we ourſelves, by the uſe of our limited powers, do often alter the courſe

(A) That ſuch was the general belief of the Greeks in the days of Homer, is plain from that poet's conſtantly introducing his deities into the narrative of his poems, and telling us that Minerva, or ſome other god, altered the minds of his heroes. "By this," ſays Plutarch, "the poet does not mean to make God *deſtroy* the will of man, but only move him to will: nor does he miraculouſly produce the appetites themſelves in men, but only cauſes ſuch imaginations as are capable of exciting them."

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of things within our ſphere from what they would be if left to the ordinary laws of motion and gravitation, without being ſaid to alter thoſe laws; why may not ſuperior beings do the ſame as inſtruments of divine providence? This idea of the intervention of ſuperior natures is beautifully illuſtrated by Thomſon in the following paſſage:

> Theſe are the haunts of meditation, theſe
> The ſcenes where ancient bards th'inſpiring breath,
> Ecſtatic, felt; and from this world retir'd,
> Convers'd with angels and immortal forms,
> On gracious errands bent: to ſave the fall
> Of virtue ſtruggling on the brink of vice;
> In waking whiſpers, and repeated dreams,
> To hint pure thought, and warn the favour'd ſoul
> For future trials fated to prepare.

We agree, however, with Mr Wollaſton, in thinking the power of theſe beings not ſo large as to alter or ſuſpend the general laws of nature (ſee MIRACLE); for the world is not like a bungling piece of clock-work, which requires to be often ſet backwards or forwards. We are likewiſe perfectly ſatisfied, that they cannot change their condition, to ape us or inferior beings; and conſequently we are not apt haſtily to credit ſtories of *portents*, &c. ſuch as cannot be true, unleſs the nature of things and their manner of exiſtence were occaſionally reverſed. Yet as men may be ſo placed as to become, even by the free exerciſe of their own powers, *inſtruments* of God's particular providence to other men; ſo may we well ſuppoſe that theſe higher beings may be ſo *diſtributed* through the univerſe, and ſubject to ſuch an economy, unknown to us, as may render *them alſo* inſtruments of the ſame providence; and that they may, in proportion to their greater abilities, be capable, *conſiſtently with the laws of nature*, of influencing human affairs in proper places.

19 Objections to the doctrine of Providence

We ſhall next proceed to ſtate ſome of the chief objections which in ancient or modern times have been brought againſt the opinion, that the world is governed by a Divine providence.

20 From the imperfections of nature,

1. The firſt of theſe is this, that the ſyſtem of nature contains many imperfections which it ought not to do if it be the work of a perfectly wiſe and good Being. To avoid the force of this objection, ſome modern writers have deſerted the ground of ſupreme and abſolute goodneſs, which the ancient theiſts always occupied, and have aſſerted that the divine perfection conſiſts in unlimited power and uncontrouled ſupremacy of will; that conſequently the Deity does not always that which is beſt, but merely what he himſelf pleaſes; and that for no other reaſon but becauſe he *wills* to do ſo. But this is no better than atheiſm itſelf. For it is of no importance to us whether the univerſe is governed by blind fate or chance, that is to ſay, by nothing at all; or whether it is governed by an arbitrary ſovereign will that is directed by chance, or at leaſt by no principle of beneficence.

21 Anſwered.

The true anſwer to this objection is, that no created ſyſtem can have every perfection, becauſe it muſt neceſſarily be deſtitute of ſelf-exiſtence and independence; and therefore if beings deſtitute of ſome perfections be better than nothing, it was worthy of infinite power and perfect goodneſs to create ſuch beings. In our preſent ſtate, we mortals ſtand upon too low ground to take a commanding view of the whole frame of things. We can only reaſon concerning what is unknown from the little that is within our reach. In that little, we can ſee that wiſdom and goodneſs reign; that nature always aims to produce perfection; that many ſalutary effects reſult even from the thunder and the ſtorm: and we doubt not that a view of the whole ſtructure of the univerſe would afford an additional triumph to the goodneſs and ſkill of its great Architect. Providence

We ſee a regular aſcent in the ſcale of beings from mere lifeleſs matter up to man; and the probability is, that the ſcale continues to aſcend as far above man in perfection as created beings can poſſibly be raiſed.—The ſole purpoſe of God in creating the world muſt have been to produce happineſs: but this would be moſt effectually done by creating, in the firſt place, as many of the moſt perfect claſs of beings as the ſyſtem could contain; and afterwards other claſſes leſs and leſs perfect, till the whole univerſe ſhould be completely full. We do not poſitively aſſert ſuch a ſcheme of creation,

> Where all muſt full, or not coherent be;
> And all that riſes, riſe in due degree,

was actually in the divine Architect's intention; but that it is poſſible, is ſufficiently obvious. No man will pretend to ſay, that this earth could afford a comfortable ſubſiſtence to a greater number of the human race, were all the inferior animals annihilated, than it could at preſent, ſwarming as every element is with life.—Suppoſe then, that as many men had been placed at firſt upon the earth as it could poſſibly ſupport, and that matters had been ſo conſtituted, as that the number ſhould never have been either increaſed or diminiſhed; we beg leave to aſk, whether, ſince there would have been evidently room for inferior animals, it would have been moſt worthy of infinite goodneſs to leave the whole globe to men, or to introduce into it different orders of leſs perfect beings, which, while they could not incommode this principal inhabitant, would each find pleaſure in its own exiſtence? To this queſtion different anſwers cannot ſurely be given. Let the reader then extend his view, and conſider the univerſe, which, however vaſt, cannot be poſitively infinite, as one ſyſtem as much united as the ſeveral parts of this globe; let him ſuppoſe that there were at firſt created as many of the higheſt order of beings as it could have contained had creation there ſtopt; let him remember that happineſs in many different degrees is valuable;—and he will not ſurely think it any imputation on the goodneſs of God that there are in the univerſe many beings far from perfection. The moſt imperfect of theſe are by themſelves better than nothing; and they all contribute to make up a ſyſtem which, conſidered as a whole, we have every reaſon to believe to be as perfect as any thing not ſelf-exiſtent can poſſibly be.

22 Objection from the introduction of evil.

2. If the world is conducted by a benevolent providence, how came evil to be introduced into it? This queſtion has perplexed mankind in all ages. The ancient Perſians reſolved it, by aſſerting the exiſtence of two gods, Oromaſdes the author of good, and Arimanius the author of evil. From them the Chriſtian heretics called *Manichees* borrowed their doctrine of two

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oppoſite co-eternal principles. Both the Platoniſts and Stoics aſcribed the origin of evil to the perverſeneſs or imperfection of matter, which they thought the Deity could not alter; and Pythagoras imagined a ſtate of pre-exiſtence, in which the ſouls of men had committed offences, for which they are here ſuffering the puniſhment. But theſe hypotheſes are, ſome of them impious, and all unſatisfactory.

23 Anſwered.

Taking the expreſſion in its moſt extenſive ſenſe, the evils to which the human race are expoſed may be reduced to *pain*, *uneaſineſs*, *diſappointment of appetites*, and *death*; of which not one could have been wholly prevented without occaſioning greater evils, inconſiſtent with the perfect goodneſs of the Creator. As long as we have ſolid bodies capable of motion, ſupported by food, ſubject to the influence of the atmoſphere, and diviſible, they muſt neceſſarily be liable to diſſolution or death: But if a man could ſuffer death, or have his limbs broken, without feeling pain, the human race had been long ago extinct. A fever is a ſtate of the body in which the fluids are in great diſorder. Felt we no uneaſineſs from that diſorder, we ſhould have no inducement to pay the proper attention to our ſtate, and ſhould certainly die unawares, without ſuſpecting ourſelves to be in danger; whereas, under the preſent adminiſtration of divine providence, the pain and ſickneſs of the diſeaſe compel us to have recourſe to the remedies proper for reſtoring us to ſoundneſs and to health. Of the uneaſineſſes to which we are liable, and which are not the effect of immediate pain, the greateſt has been ſometimes ſaid to ariſe from the apprehenſion of death, which conſtantly ſtares us in the face, and frequently embitters all our pleaſures even in the hour of perfect health.—But this dread of death is implanted in our breaſts for the very beſt of purpoſes. Had we no horror at the apprehenſion of death, we ſhould be apt, whenever any misfortune befel us, to quit this world raſhly, and ruſh unprepared into the preſence of our Judge: but the horror which attends our reflections on our own diſſolution, ariſing not from any apprehenſions of the pain of dying, but from our anxiety concerning our future ſtate of exiſtence, tends ſtrongly to make us act, while we are here, in ſuch a manner as to enſure our happineſs hereafter. Add to this, that the fear of death is the greateſt ſupport of human laws. We every day ſee perſons breaking through all the regulations of ſociety and good life, notwithſtanding they know death to be the certain conſequence, and feel all the horrors of it that are natural to man: and therefore were death diveſted of theſe horrors, how inſignificant would capital puniſhments be as guardians of the law, and how inſecure would individuals be in civil ſociety?

With regard to the unavoidable misfortunes and anxieties of our preſent ſtate, ſo far from being truly hurtful in themſelves, they are proofs of divine beneficence. When we ſee men diſpleaſed with their ſituation, when we hear them complain of the difficulties, the miſeries, and the cares of life, of the hardſhips which they have undergone, and the labours which ſtill lie before them; inſtead of accounting them unfortunate, we ought to regard them as active beings, placed in the only ſituation that is fit for the improvement of their nature. That diſcontent, theſe reſtleſs wiſhes to improve their condition, are ſo many ſure indications that their faculties will not languiſh. They who are in the leaſt degree accuſtomed to obſerve the human character, know well the influence which pleaſure and repoſe have in enfeebling every manly principle, and how capable they are of attaching us even to a ſordid and diſhonourable exiſtence. Providence

Happy indeed it is for the human race, that the number of thoſe men is ſmall whom providence has placed in ſituations in which perſonal activity is unneceſſary. By far the greater number are compelled to exert themſelves, to mix and to contend with their equals, in the race of fortune and of honour. It is thus that our powers are called forth, and that our nature reaches its higheſt perfection. It is even perhaps a general truth, that they who have ſtruggled with the greateſt variety of hardſhips, as they always acquire the higheſt energy of character, ſo if they have retained their integrity, and have not ſunk entirely in the conteſt, ſeldom fail to ſpend their remaining days reſpectable and happy, ſuperior to paſſion, and ſecured from folly by the poſſeſſion of a wiſdom dearly earned.

24 Phyſical evil the cauſe of moral good.

But the benefits of phyſical evils have been ſet in a ſtill ſtronger light by a great maſter of moral wiſdom, who was himſelf ſubject to many of thoſe evils. That man is a moral agent, ſent into this world to acquire habits of virtue and piety to fit him for a better ſtate, is a truth to which no conſiſtent theiſt will for a moment refuſe his aſſent. But almoſt all the moral good which is left among us, is the apparent effect of phyſical evil.

"Goodneſs is divided by divines into ſoberneſs, righteouſneſs, and godlineſs. Let it be examined how each of theſe duties would be practiſed if there were no phyſical evil to enforce it. *Johnſon's Idler.* n° 89.

"Sobriety or temperance is nothing but the forbearance of pleaſure; and if pleaſure was not followed by pain, who would forbear it? We ſee every hour thoſe in whom the deſire of preſent indulgence overpowers all ſenſe of paſt, and all foreſight of future miſery. In a remiſſion of the gout, the drunkard returns to his wine, and the glutton to his feaſt; and if neither diſeaſe nor poverty were felt or dreaded, every one would ſink down in idle ſenſuality, without any care of others, or of himſelf. To eat and drink, and lie down to ſleep, would be the whole buſineſs of mankind.

"Righteouſneſs, or the ſyſtem of ſocial duty, may be ſubdivided into juſtice and charity. Of juſtice, one of the heathen ſages has ſhown, with great acuteneſs, that it was impreſſed upon mankind only by the inconveniences which injuſtice had produced. 'In the firſt ages (ſays he) men acted without any rule but the impulſe of deſire; they practiſed injuſtice upon others, and ſuffered it from others in their turn: but in time it was diſcovered, that the pain of ſuffering wrong was greater than the pleaſure of doing it; and mankind, by a general compact, ſubmitted to the reſtraint of laws, and reſigned the pleaſure to eſcape the pain.'

"Of charity, it is ſuperfluous to obſerve, that it could have no place if there were no want; for of a virtue which could not be practiſed, the omiſſion could not be culpable. Evil is not only the occaſional but the efficient cauſe of charity; we are incited to the relief of miſery by the conſciouſneſs that we have the ſame nature with the ſufferer; that we are in danger of the ſame diſtreſſes, and may ſome time implore the ſame aſſiſtance.

"Godlineſs

Providence

"Godlineſs or piety is elevation of the mind towards the Supreme Being, and extenſion of the thoughts of another life. The other life is future, and the Supreme Being is inviſible. None would have recourſe to an inviſible power, but that all other ſubjects had eluded their hopes. None would fix their attention upon the future, but that they are diſcontented with the preſent. If the ſenſes were feaſted with perpetual pleaſure, they would always keep the mind in ſubjection. Reaſon has no authority over us but by its power to warn us againſt evil.

"In childhood, while our minds are yet unoccupied, religion is impreſſed upon them; and the firſt years of almoſt all who have been well educated are paſſed in a regular diſcharge of the duties of piety: But as we advance forward into the crowds of life, innumerable delights ſolicit our inclinations, and innumerable cares diſtract our attention. The time of youth is paſſed in noiſy frolics; manhood is led on from hope to hope, and from project to project; the diſſoluteneſs of pleaſure, the inebriation of ſucceſs, the ardour of expectation, and the vehemence of competition, chain down the mind alike to the preſent ſcene: nor is it remembered how ſoon this miſt of trifles muſt be ſcattered, and the bubbles that float upon the rivulet of life be loſt for ever in the gulph of eternity. To this conſideration ſcarce any man is awakened but by ſome preſſing and reſiſtleſs evil; the death of thoſe from whom he derived his pleaſures, or to whom he deſtined his poſſeſſions, ſome diſeaſe which ſhows him the vanity of all external acquiſitions, or the gloom of age which intercepts his proſpects of long enjoyment, forces him to fix his hopes upon another ſtate; and when he has contended with the tempeſts of life till his ſtrength fails him, he flies at laſt to the ſhelter of religion.

"That miſery does not make all virtuous, experience too certainly informs us; but it is no leſs certain, that of what virtue there is, miſery produces far the greater part. Phyſical evil may be therefore endured with patience, ſince it is the cauſe of moral good; and patience itſelf is one virtue by which we are prepared for that ſtate in which evil ſhall be no more."

25 Objection from the permiſſion of moral guilt,

The calamities and the hardſhips of our preſent ſtate, then, are ſo far from being real evils, of which providence ought to be accuſed, that in every point of view in which we can conſider them, they afford the ſureſt proofs of the wiſdom of its adminiſtration, and of its goodneſs to man.

The moſt ſerious difficulty lies in accounting for the permiſſion of moral evil or guilt, in a ſyſtem governed by infinite benevolence and wiſdom. Thoſe who in a conſiſtent manner hold the doctrine of the abſolute neceſſity of human actions in its full extent, and acknowledge all its conſequences, find it eaſy to elude this difficulty. They very fairly deny the exiſtence of any ſuch thing as moral evil in the abſtract; and aſſert, that what we call a *crime*, is nothing more than an action which we always regard with a painful ſenſation: that theſe apparent evils endure only for a time; and that all will at laſt terminate in the perfection and happineſs of every intelligent being.

26 Anſwered.

Upon the ſyſtem of liberty, the ſhorteſt anſwer ſeems to be this: that ſome things are abſolutely impoſſible, not from any weakneſs in the Deity, but becauſe they infer abſurdity or contradiction. Thus it is impoſſible for twice two to be any thing elſe than four; and thus it is impoſſible for Omnipotence itſelf to confer ſelf-approbation upon an intelligent being who has never deſerved it; that is to ſay, it is impoſſible for a man of ſenſe to be pleaſed with himſelf for having done a certain action, while he himſelf is conſcious that he never did that action. But ſelf-approbation conſtitutes the higheſt, the moſt unmingled, and permanent felicity, of which our nature is capable. It is not in the power of Omnipotence itſelf, then, to beſtow the higheſt and moſt permanent felicity of our nature; it muſt be *earned* and deſerved before it can be obtained. In the ſame manner good deſert, virtue or merit, cannot be *conferred*; they muſt be *acquired*. To enable us to acquire theſe, we muſt be expoſed to difficulties, and muſt ſuffer in a certain degree. If theſe difficulties had no influence upon our conduct and feelings, if they expoſed us to no real danger, no fabric of merit and of ſelf-approbation could be reared upon them. All that the Supreme Being could do for us, was to confer ſuch an original conſtitution and character as would enable us to do well if we ſhould exert our utmoſt powers. The univerſe is not ruled by favour, but by juſtice. Complete felicity muſt be purchaſed. Guilt is an abuſe of our freedom, a doing ill where we could have done well, and is entirely the work of man. Heaven could not avoid permitting its exiſtence, and expoſing us to danger; for temptation is neceſſary to virtue, and virtue is the perfection of our nature, our glory, and our happineſs.

27 By Simplicius.

The permiſſion of moral evil has been ſo ably accounted for by Simplicius, a Pagan writer, and therefore not biaſſed by any partiality to the Jewiſh or Chriſtian Scriptures, that we cannot deny ourſelves the pleaſure of laying his reaſoning before our readers He aſks *, "Whether God may be called the author of ſin, becauſe he permits the ſoul to uſe her liberty? and anſwers the queſtion thus:

* *Simplic. Com. in Epict.* pag. 186, 187. *ed. Salmaſ.*

"He who ſays that God ſhould not permit the exerciſe of its freedom to the ſoul, muſt affirm one of theſe two things; either that the ſoul, though by nature capable of indifferently chooſing *good* or *evil*, ſhould yet be conſtantly prevented from chooſing evil; or elſe that it ſhould have been made of ſuch a nature as to have no *power* of chooſing *evil*.

"The former aſſertion (continues he) is irrational and abſurd; for what kind of liberty would that be in which there ſhould be no freedom of choice? and what choice could there be, if the mind were conſtantly reſtrained to one ſide of every alternative? With reſpect to the ſecond aſſertion, it is to be obſerved (ſays he), that no evil is in itſelf deſirable, or can be choſen *as evil*. But if this power of determining itſelf either way in any given caſe muſt be taken from the ſoul, it muſt either be as ſomething not good, or as ſome great evil. But whoever ſaith ſo, does not conſider how many things there are which, though accounted good and deſirable, are yet never put in competiton with this freedom of will: for without it we ſhould be on a level with the brutes; and there is no perſon who would rather be a brute than a man. If God then ſhows his goodneſs in giving to inferior beings ſuch perfections as are far below this, is it incongruous to the divine nature and goodneſs to give man a ſelf-determining power over his actions, and to permit him the free exerciſe of that power?

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power? Had God, to prevent man's ſin, taken away the liberty of his will, he would likewiſe have deſtroyed the foundation of all virtue, and the very nature of man; for there could be no virtue were there not a poſſibility of vice; and man's nature, had it continued rational, would have been divine, becauſe impeccable. Therefore (continues he), though we attribute to God, as its author, this ſelf-determining power, which is ſo neceſſary in the order of the univerſe; we have no reaſon to attribute to him that evil which comes by the abuſe of liberty: For God doth not cauſe that averſion from good which is in the ſoul when it ſins; he only gave to the ſoul ſuch a power as might turn itſelf to evil, out of which he produces much good, which, without ſuch a power, could not have been produced by Omnipotence itſelf." So conſonant to the doctrine of our ſcriptures is the reaſoning of this opponent of the writings of Moſes! *Fas eſt et ab hoſte doceri.*

28 Objection from the apparent confuſion of human affairs,

The laſt objection to the belief of a divine providence ariſes from the apparent confuſion of human affairs, that all things happen alike to all, that bad men are proſperous, and that a total want of juſtice appears to attend the divine adminiſtrations. Even the beſt men have at times been ſhaken by this conſideration.—But there are many reaſons for rendering this world a mixed ſcene: it would become unfit for a ſtate of trial and of education to virtue were it otherwiſe.

29 Anſwered,

It has been ſhown already, that phyſical evil is the parent of moral good; and therefore it would be abſurd to expect that the virtuous ſhould be entirely exempted from that evil. For the occaſional proſperity of the wicked, many reaſons have been aſſigned even by thoſe who, in their diſquiſitions, were not guided by that revelation which has brought to light life and immortality. "God (ſays Plutarch) ſpares the wicked, that he may ſet to mankind an example of forbearance, and teach them not to revenge their injuries too haſtily on each other. He ſpares ſome wicked men from early puniſhment, in order to make them inſtruments of his juſtice in puniſhing others. And he ſpares all for a time, that they may have leiſure for repentance; for men (ſays the ſame excellent moraliſt) look at nothing further, in the puniſhments which they inflict, than to ſatisfy their revenge and malice, and therefore they purſue thoſe who have offended them with the utmoſt rage and eagerneſs; whereas God, aiming at the cure of thoſe who are not utterly incurable, gives them μεταλλαξασθαι χρονον, "time to be converted."

30 By Plutarch.

But this objection receives the beſt ſolution from the doctrine of the immortality of the human ſoul.

31 The immortality of the ſoul the beſt anſwer to this objection.

——And ſee!
'Tis come, the glorious morn! the ſecond birth
Of heav'n and earth! awakening nature hears
The *new creating word*, and ſtarts to life,
In every height'ned form, from pain and death
For ever free. *The great eternal ſcheme*,
Involving all, and in a *perfect whole*
Uniting, as the proſpect wider ſpreads,
To reaſon's eye cleared up a-pace.
Ye vainly wiſe! Ye blind preſumptuous! now,
Confounded in the duſt, adore that Pow'r
And Wiſdom oft arraign'd: ſee now the cauſe,
Why unaſſuming worth in ſecret liv'd
And died neglected: why the good man's ſhare
In life was gall and bitterneſs of ſoul:
Why the lone widow and her orphans pin'd
In ſtarving ſolitude; while luxury,
In palaces, lay ſtraining her low thought,
To form unreal wants: why heav'n-born truth,
And moderation fair, wore the red marks
Of ſuperſtition's ſcourge: why licens'd pain,
That cruel ſpoiler, that emboſom'd foe,
Imbitter'd all our bliſs. Ye good diſtreſt!
Ye noble few! who here unbending ſtand
Beneath life's preſſure, yet bear up a while,
And what your bounded view, which only ſaw
A little part, deem'd evil, is no more:
The ſtorms of wintry time will quickly paſs,
And one unbounded ſpring encircle all.

Thomſon's Winter.

Providence || Provoſt.

Providence-Plantation, a colony of New-England, which, with Rhode-iſland, formerly conſtituted a charter government. Its chief town is Newport.

Providence, one of the leaſt of the Bahama iſlands in the American ocean, but the beſt of thoſe planted and fortified by the Engliſh. It is ſeated on the eaſt ſide of the gulph of Florida. W. Long. 77. 35. N. Lat. 25. 0.

PROVINCE, in Roman antiquity, a country of conſiderable extent, which, upon being entirely reduced under the Roman dominion, was new-modelled according to the pleaſure of the conquerors, and ſubjected to the command of annual governors, ſent from Rome; being commonly obliged to pay ſuch taxes and contributions as the ſenate thought fit to demand.

Of theſe countries, that part of France next the Alps was one, and ſtill retains the name *Provence*.

Nicod derives the word *a procul vivendo*, "living afar off;" but it is better deduced from *pro* and *vinco* "I overcome."

Province, in geography, a diviſion of a kingdom or ſtate, compriſing ſeveral cities, towns, &c. all under the ſame government, and uſually diſtinguiſhed by the extent either of the civil or eccleſiaſtical juriſdiction.

The church diſtinguiſhes its provinces by archbiſhoprics; in which ſenſe, England is divided into two provinces, Canterbury and York.

The United Provinces are ſeven provinces of the Netherlands, who, revolting from the Spaniſh dominion, made a perpetual alliance, offenſive and defenſive, at Utrecht, anno 1579. See *United Provinces*.

PROVINCIAL, ſomething relating to a province. It alſo denotes, in Romiſh countries, a perſon who has the direction of the ſeveral convents of a province.

PROVISIONS, in a military ſenſe, implies all manner of eatables, food or provender, uſed in an army, both for man and beaſt.

PROVOST of a city or town, is the chief municipal magiſtrate in ſeveral trading cities, particularly Edinburgh, Paris, &c. being much the ſame with mayor in other places. He preſides in city-courts, and, together with the bailies, who are his deputies, determines in all differences that ariſe among citizens.

The provoſt of Edinburgh is called *lord*, and the ſame title is claimed by the provoſt of Glaſgow. The former calls yearly conventions of the royal boroughs to Edinburgh by his miſſives, and is, *ex officio*, preſident to the convention when met.

Provoſt || Prudence.

PROVOST, *or Prevot-Royal*, a ſort of inferior judge formerly eſtabliſhed throughout France, to take cognizance of all civil, perſonal, real, and mixed cauſes, among the people only.

Grand PROVOST *of France*, or *of the Houſehold*, had juriſdiction in the king's houſe, and over the officers therein; looked to the policy thereof, the regulation of proviſions, &c.

Grand PROVOST *of the Conſtable*, a judge who manages proceſſes againſt the ſoldiers in the army who have committed any crime.

He has four lieutenants diſtributed throughout the army, called *provoſts of the army*, and particularly provoſts in the ſeveral regiments.

Provost Marſhal of an Army, is an officer appointed to ſeize and ſecure deſerters, and all other criminals. He is to hinder ſoldiers from pillaging, to indict offenders, and ſee the ſentence paſſed on them executed. He alſo regulates the weights and meaſures, and the price of proviſions, &c. in the army. For the diſcharge of his office, he has a lieutenant, a clerk, and a troop of marſhal-men on horſeback, as alſo an executioner.

There is alſo a provoſt-marſhal in the navy, who hath charge over priſoners, &c.

The French alſo had a provoſt-general of the marines, whoſe duty it was to proſecute the marines when guilty of any crime, and to make report thereof to the council of war; beſides a marine provoſt in every veſſel, who was a kind of gaoler, and took the priſoners into his care, and kept the veſſel clean.

Provosts of the Marſhals, were a kind of lieutenants of the marſhals of France; of theſe there were 180 ſeats in France; their chief juriſdiction regarded highwaymen, ſootpads, houſe-breakers, &c.

Provost of the Mint, a particular judge inſtituted for the apprehending and proſecuting of falſe coiners.

PROVOST, or *Prevot*, in the king's ſtables; his office is to attend at court, and hold the king's ſtirrup when he mounts his horſe. There are four provoſts of this kind, each of whom attends in his turn, monthly.

PROW, denotes the head or fore-part of a ſhip, particularly in a galley; being that which is oppoſite to the poop or ſtern.

PROXIMITY, denotes the relation of nearneſs, either in reſpect of place, blood, or alliance.

PRUDENCE, in ethics, may be defined an ability of judging what is beſt, in the choice both of ends and means. According to the definition of the Roman moraliſt, *De Officiis*, lib. i. cap. 43. prudence is the knowledge of what is to be deſired or avoided. Accordingly, he makes *prudentia* (*De Legibus*, lib. i.) to be a contraction of *providentia*, or foreſight. Plato (*De Legibus*, lib. iii.) calls this the leading virtue; and Juvenal, Sat. x. obſerves,

Nullum numen abeſt ſi ſit prudentia.

The idea of prudence includes ευβυλια, or due conſultation; that is, concerning ſuch things as demand conſultation in a right manner, and for a competent time, that the reſolution taken up may be neither too precipitate nor too ſlow; and συνησις, or a faculty of diſcerning proper means when they occur; and to the perfection of prudence, theſe three things are farther required, viz. δεινοτης, or a natural ſagacity; αγχινοια, preſence of mind, or a ready turn of thought; and εμπειρια, or experience. The extremes of prudence are craft or cunning on the one hand, which is the purſuit of an ill end by direct and proper though not honeſt means; and folly on the other, which is either a miſtake, both as to the end and means, or proſecuting a good end by foreign and improper means. Grove's *Moral Philoſophy*, vol. ii. chap. ii.. Prudentius || Pruning.

PRUDENTIUS, or AURELIUS PRUDENTIUS CLEMENS, a famous Chriſtian poet, under the reign of Theodoſius the Great, who was born in Spain in the year 348. He firſt followed the profeſſion of an advocate, was afterwards a judge, then a ſoldier, and at length had an honourable employment at court. We have a great number of his poems, which, from the choice of his ſubjects, may be termed *Chriſtian poems;* but the ſtyle is barbarous, and very different from the purity of the Auguſtan age. The moſt eſteemed editions of Prudentius's works are that of Amſterdam, in 1667, with Heinſius's Notes, and that of Paris in 1687, *in uſum Delphini.*

PRUNELLA, in botany: A genus of the gymnoſpermia order, belonging to the didynamia claſs of plants; and in the natural method ranking under the 12th order, *holoraceæ*. The filaments are bifurcated, with an anthera only on one point; the ſtigma is bifid.

PRUNES, are plums dried in the ſunſhine, or in an oven.

PRUNING, in gardening and agriculture, is the lopping off the ſuperfluous branches of trees, in order to make them bear better fruit, grow higher, or appear more regular.

Pruning, though an operation of very general uſe, is nevertheleſs rightly underſtood by few; nor is it to be learned by rote, but requires a ſtrict obſervation of the different manners of growth of the ſeveral ſorts of fruit-trees; the proper method of doing which cannot be known without carefully obſerving how each kind is naturally diſpoſed to produce its fruit: for ſome do this on the ſame year's wood, as vines; others, for the moſt part, upon the former year's wood, as peaches, nectarines, &c.; and others upon ſpurs which are produced upon wood of three, four, &c. to fifteen or twenty years old, as pears, plums, cherries, &c. Therefore, in order to the right management of fruit-trees, proviſion ſhould always be made to have a ſufficient quantity of bearing wood in every part of the trees; and at the ſame time there ſhould not be a ſuperfluity of uſeleſs branches, which would exhauſt the ſtrength of the trees, and cauſe them to decay in a few years.

The reaſons for pruning of fruit-trees, are, 1. To preſerve them longer in a vigorous bearing-ſtate; 2. To render them more beautiful; and, 3. To cauſe the fruit to be larger and better taſted.

The general inſtructions for pruning are as follow. The greateſt care ought to be taken of fruit-trees in the ſpring, when they are in vigorous growth; which is the only proper ſeaſon for procuring a quantity of good wood in the different parts of the tree, and for diſplacing all uſeleſs branches as ſoon as they are produced, in order that the vigour of the tree may be entirely diſtributed to ſuch branches only as are deſigned to remain. For this reaſon trees ought not to be neglected in April and May, when their ſhoots are produced: however, thoſe branches which are intended for bearing the

Pruning. the ſucceeding year ſhould not be ſhortened during the time of their growth, becauſe this would cauſe them to produce two lateral ſhoots, from the eyes below the place where they were ſtopped, which would draw much of the ſtrength from the buds of the firſt ſhoot: and if the two lateral ſhoots are not entirely cut away at the winter-pruning, they will prove injurious to the tree. This is to be chiefly underſtood of ſtone-fruit and grapes; but pears and apples, being much harder, ſuffer not ſo much, though it is a great diſadvantage to thoſe alſo to be thus managed. It muſt likewiſe be remarked, that peaches, nectarines, apricots, cherries, and plums, are always in the greateſt vigour when they are leaſt maimed by the knife; for where large branches are taken off, they are ſubject to gum and decay. It is therefore the moſt prudent method to rub off all uſeleſs buds when they are firſt produced, and to pinch others, where new ſhoots are wanted to ſupply the vacancies of the wall; by which management they may be ſo ordered as to want but little of the knife in winter-pruning. The management of pears and apples is much the ſame with theſe trees in ſummer; but in winter they muſt be very differently pruned: for as peaches and nectarines, for the moſt part, produce their fruit upon the former year's wood, and muſt therefore have their branches ſhortened according to their ſtrength, in order to produce new ſhoots for the ſucceeding year; ſo, on the contrary, pears, apples, plums, and cherries, producing their fruit upon ſpurs, which come out of the wood of five, ſix, and ſeven years old, ſhould not be ſhortened, becauſe thereby thoſe buds which were naturally diſpoſed to form theſe ſpurs, would produce wood-branches; by which means the trees would be filled with wood, but would never produce much fruit. The branches of ſtandard-trees ſhould never be ſhortened unleſs where they are very luxuriant, and, by growing irregularly on one ſide of the trees, attract the greateſt part of the ſap, by which means the other parts are either unfurniſhed with branches, or are rendered very weak; in which caſe the branch ſhould be ſhortened down as low as is neceſſary, in order to obtain more branches to fill up the hollow of the tree: but this is only to be underſtood of pears and apples, which will produce ſhoots from wood of three, four, or more years old; whereas moſt ſorts of ſtone-fruit will gum and decay after ſuch amputations: whenever this happens to ſtone-fruit, it ſhould be remedied by ſtopping or pinching thoſe ſhoots in the ſpring, before they have obtained too much vigour, which will cauſe them to puſh out ſide-branches; but this muſt be done with caution. You muſt alſo cut out all dead or decaying branches, which cauſe their heads to look ragged, and alſo attract noxious particles from the air: in doing of this, you ſhould cut them cloſe down to the place where they were produced, otherwiſe that part of the branch which is left will alſo decay, and prove equally hurtful to the reſt of the tree; for it ſeldom happens, when a branch begins to decay, that it does not die quite down to the place where it was produced, and if permitted to remain long uncut, often infects ſome of the other parts of the tree. If the branches cut off are large, it will be very proper, after having ſmoothed the cut part exactly even with a knife, chiſſel, or hatchet, to put on a plaſter of grafting clay, which will prevent the wet from ſoaking into the tree at the wounded part. All ſuch branches as run acroſs each other, and occaſion a confuſion in the head of the tree, ſhould be cut off; and as there are frequently young vigorous ſhoots on old trees, which riſe from the old branches near the trunk, and grow upright into the head, theſe ſhould be carefully cut out every year, leſt, by being permitted to grow, they fill the tree too full of wood. Pruning.

As to the pruning of foreſt-trees, if they be large, it is beſt not to prune them at all; yet, if there be an abſolute neceſſity, avoid taking off large boughs as much as poſſible. And, 1. If the bough be ſmall, cut it ſmooth, cloſe, and ſloping. 2. If the branch be large, and the tree old, cut it off at three or four feet from the ſtem. 3. If the tree grow crooked, cut it off at the crook, ſloping upward, and nurſe up one of the moſt promiſing ſhoots for a new ſtem. 4. If the tree grow top-heavy, its head muſt be lightened, and that by thinning the boughs that grow out of the main branches. But if you would have them ſpring, rub off the buds, and ſhroud up the ſide-ſhoots. 5. If the ſide-bough ſtill break out, and the top be able to ſuſtain itſelf, give the boughs that put forth in ſpring a pruning after Midſummer, cutting them cloſe.

PRUNUS, in botany: A genus of the monogynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 36th order, *Pomaceæ*: The calyx is quinquefid, inferior; there are five petals; the fruit is a plum, having a kernel with prominent ſutures. There are 15 ſpecies, of which ſix are cultivated in Britain: they are originally natives of America and Siberia.

1. The domeſtica, or common plum-tree, grows 20 or 30 feet high, garniſhed with oval, ſpear-ſhaped leaves, and with the pedunculi for the moſt part ſingle, terminated by flowers, ſucceeded by plums of many different colours, ſizes, and ſhapes in the varieties. 2. The inſititia, wild-plum, or bullace-tree, grows 12 or 15 feet high; the branches ſomewhat ſpinous; the leaves oval, hairy underneath; and the pedunculi by pairs, terminated by white flowers ſucceeded by ſmall, round, plum-like, fruit of different colours in the varieties. 3. The ſpinoſa, black-thorn, or ſloe-tree, grows 10 or 12 feet high, very branchy and buſhy quite from bottom, armed with ſtrong, ſharp ſpines, ſmall, ſpear-ſhaped, ſmooth leaves, pedunculi growing ſingly, terminated by flowers, ſucceeded by ſmall, round, black cherries in autumn. It grows wild everywhere in hedges and woods; and is very proper for planting field hedges, being of very quick and cloſe growth. 4. The ceraſus, or common cherry-tree, grows 20 feet or more in height, garniſhed with oval cluſters of lanceolate, ſmooth leaves, umbellate flowers, ſucceeded by cluſters of red roundiſh fruit of different ſizes and properties in the varieties. Hanbury ſays, "were this tree ſcarce, and with much difficulty propagated, every man, though poſſeſſed of a ſingle tree only, would look upon it as a treaſure; for beſides the charming appearance theſe trees have, when beſnowed, as it were, all over with bloom in the ſpring, can any tree in the vegetable tribe be conceived more beautiful, ſtriking, and grand, than a well-grown and healthy cherry-tree, at that period when the fruit is ripe."

The many kinds of cherry-trees afford an almoſt endleſs variety; all differing in ſome reſpect in their manner of ſhooting, leaves, flowers, or fruit: two in particular demand admiſſion into the pleaſure-garden; the double-bloſſomed and the red-flowering. The pleaſing ſhow the common cherry-tree makes when in blow is known

Pruning. known to all; but that of the double-bloſſomed is much more enchanting. It bloſſoms like the other in May; the flowers are produced in large and noble cluſters; for each ſeparate flower is as double as a roſe, is very large, and placed on long and ſlender footſtalks, ſo as to occaſion the branches to have an air of eaſe and freedom. They are of a pure white; and the trees will be ſo profuſely covered with them, as to charm the imagination. Standards of theſe trees, when viewed at a diſtance, have been compared to balls of ſnow; and the nearer we approach, the greater pleaſure we receive. Theſe trees may be kept as dwarfs, or trained up to ſtandards; ſo that there is no garden or plantation to which they will not be ſuitable. By the multiplicity of the petals the organs of generation are deſtroyed; ſo that thoſe flowers which are really full are never ſucceeded by any fruit.

The red-flowering cherry-tree differs in no reſpect from the common cherry-tree, only that the flowers are of a pale-red colour, and by many are eſteemed on that account. Beſides the ornament and utility afforded us by the flowers and fruit of the cherry, its timber is a further inducement for propagating it; more eſpecially that of the ſmall black wilding ſort; which may perhaps with propriety be conſidered as the genuine ſpecies, and a native of this iſland. Be this as it may, it will grow, in a ſoil and ſituation it affects, to be a large timber tree; which, if taken in its prime before it become tainted at the heart, will turn out perhaps not leſs than a ton of valuable materials, peculiarly adapted to the purpoſes of furniture. The grain is fine, and the colour nearly approaching to that of mahogany, to which valuable wood it comes nearer than any other which this country produces. 5. The avium, or great wild-cherry tree, grows 40 or 50 feet high, having oval, ſpear-ſhaped leaves, downy underneath, with umbellate ſeſſile cluſters of white flowers, ſucceeded by ſmall round fruit of different properties in the varieties. 6. The padus, or common bird-cherry tree, grows 15 or 20 feet high, of a ſhrub-like growth, with a ſpreading head, large, oblong, rough, ſerrated leaves, having two glands at the back of the baſe like the other, and with ſhorter, more compact cluſters of flowers, ſucceeded by large red fruit. This grows wild in hedges in the north parts of England. 7. The Virginiana, or Virginian bird-cherry, grows 30 feet high, dividing into a very branchy head, having a dark purple bark, oval, ſlightly ſerrated, ſhining green leaves, having two glands at the forepart of the baſe, and long cluſters of white flowers, ſucceeded by ſmall, round, berry-like, black fruit. 8. The Canadenſis, or Canada dwarf bird cherry, grows but four or five feet high, branching horizontally near the ground with ſmooth branches; broad, ſpear-ſhaped, rough downy leaves without glands; and long cluſters of white flowers, ſucceeded by ſmall, round, berry-like, black fruit, ripe in autumn. 9. The mahaleb, or perfumed cherry, grows 10 or 15 feet high, with ſmooth whitiſh branches, ſmall, oval, ſhining green leaves, and corymbous cluſters of white flowers, ſucceeded by ſmall fruit. 10. The armeniaca, or apricot tree, grows 20 feet high, with a large ſpreading head, having reddiſh ſhoots, large nearly heart-ſhaped leaves, and cloſe-ſitting pale-red flowers riſing all along the ſides of the young branches; ſucceeded by large, roundiſh fruit of a yellow and reddiſh colour in different varieties. The fruit and the kernels of the *Prunus Siberica*, when eaten, excite a continued head-ach: the kernels, infuſed in brandy, communicate an agreeable flavour. Pruſa || Pruſſia.

Culture. All the different varieties of plums have at firſt been raiſed from the ſtones, and are afterwards preſerved by budding and grafting on any plum-ſtock. The ſame method is applicable to cherries; only theſe are grafted to moſt advantage upon ſtocks of the wild black and red cherry raiſed from the ſtones of the fruit. The apricot-trees are propagated by budding on any kind of plum-ſtocks.

PRUSA (anc. geog.), a town ſituated at mount Olympus in Myſia, built by Pruſias, who waged war with Croeſus, (Strabo); with Cyrus, (Stephanus); both cotemporary princes. Now called *Burſa* or *Pruſa*, capital of Bithynia, in Aſia Minor. E. Long. 29. 5. N. Lat. 39. 22.

PRUSIAS, the name of ſeveral kings of Bithynia.

Prusias, a town of Bithynia, anciently called *Cios*, from a cognominal river, and giving name to the Sinus Cianus of the Propontis; rebuilt by Pruſias the ſon of Zela, after having been deſtroyed by Philip the ſon of Demetrius: it ſtood on the Sinus Cianus, at the foot of mount Arganthonius. This is the Pruſias who harboured Annibal after the defeat of Antiochus.—Of this place was Aſclepiades, ſurnamed *Pruſieus*, the famous phyſician.

PRUSSIA, a modern, but deſervedly celebrated kingdom of Europe, whoſe monarch, along with Pruſſia Proper, poſſeſſes alſo the electorate of Brandenburg, and ſome other territories of conſiderable extent. The diſtrict properly called *Pruſſia* is of great extent, and divided into the Ducal and Regal Pruſſia, the latter belonging to the republic of Poland till the late partition of the Poliſh territories. Both together are of great extent; being bounded on the north by the Baltic, on the ſouth by Poland and the duchy of Mazovia, on the weſt by Pomerania, and on the eaſt by Lithuania and Samogitia. The name is by ſome thought to be derived from the *Boruſſi*, a tribe of the Sarmatians, who, migrating from the foot of the Riphæan mountains, were tempted by the beauty and fertility of the country to ſettle there. Others think that the name of this country is properly *Poruſſia; Po* in the language of the natives ſignifying *near*, and *Poruſſia* ſignifying *near Ruſſia*. To the latter etymology we find the king of Pruſſia himſelf aſſenting in the treatiſe intitled *Memoirs of the Houſe of Brandenburg*. However, it muſt be owned, that theſe or any other etymologies of the word are very uncertain, and we find nothing like it mentioned by hiſtorians before the tenth century. Plate CCCCX. 1 Etymology of the name.

The ancient ſtate of Pruſſia is almoſt entirely unknown. However, the people are ſaid to have been very ſavage and barbarous; living upon raw fleſh, and drinking the blood of horſes at their feaſts, according to Stella, even to intoxication (A). Nay, ſo extreme- 2 Extreme barbarity of the ancient inhabitants.

ly

(A) This author does not mention any particular method by which they communicated an inebriating quality to the blood of animals. Poſſibly, however, the vital fluid may have a property of this kind, though unknown in our days where ſuch barbarous cuſtoms are diſuſed. Drunkenneſs from drinking blood is frequently mentioned in Scripture, but whether literally or metaphorically muſt be decided by the learned.

Pruſſia.

ly ſavage were this people, that they were even unacquainted with the method of conſtructing huts, and took up their dwelling in caves and cavities of rocks and trees, where they protected themſelves and children from the inclemencies of the weather. Among ſuch a people it is vain to expect that any tranſactions would be recorded, or indeed that any thing worthy of being recorded would be tranſacted. We ſhall therefore begin our hiſtory of Pruſſia with the time when the Teutonic knights firſt got footing in the country. (See *Teutonic Knights*).

3 Teutonic knights firſt get footing in the country.

On the expulſion of the Chriſtians from the Holy Land by Saladin, a ſettlement was given to the Teutonic knights in Pruſſia by Conrade duke of Mazovia, the competitor of Boleſlaus V. for the crown of Poland. Their firſt reſidence in this country was Culm; to which territory they were confined by the conditions of the donation, excepting what they could conquer from their pagan neighbours, all which the emperor granted to them in perpetuity.

Encouraged by this grant, the knights conquered the greateſt part of the country which now goes by the name of *Pruſſia*; and, not content with this, became very troubleſome to Poland, inſomuch that the monarchs of that kingdom were ſometimes obliged to carry on dangerous and bloody wars with them; for an account of which we refer to the article Poland, n° 61. 67, &c.

The Teutonic order continued in Pruſſia till the year 1531. Their laſt grand-maſter was Albert marquis of Brandenburg, and nephew to Sigiſmund I. king of Poland. He was preferred to this dignity in hopes that his affinity to Sigiſmund might procure a reſtitution of ſome of the places which had been taken from the order during the former unſucceſsful wars with Poland; but in this the fraternity were diſappointed. Albert, however, was ſo far from endeavouring to obtain any favour from his uncle by fair means, that he refuſed to do homage to him, and immediately began to make preparations for throwing off his dependence altogether, and recovering the whole of Pruſſia and Pomerania by force of arms. In this he was ſo far from ſucceeding, that, being foiled in every attempt, he was forced to reſign the dignity of grand-maſter; in recompenſe for which, his uncle beſtowed on him that part of Pruſſia now called *Ducal*, in quality of a ſecular duke. It was now the intereſt of the houſe of Brandenburg to aſſiſt in the expulſion of the fraternity; and accordingly, being at laſt driven out of Pruſſia and Pomerania, they transferred their chapter to Mariendal in Franconia; but in that and other provinces of the empire where they ſettled, little more than the name of the order once ſo famous now remains.

4 Expelled.

5 Hiſtory of Brandenburg.

The other moſt conſiderable part of his Pruſſian majeſty's dominions is the Electorate of Brandenburg. Like other parts of Germany, it was anciently poſſeſſed by barbarians, of whom no hiſtory can be given. Theſe were ſubdued by Charlemagne, as is related under the article France *; but being on every occaſion ready to revolt, in 927 Henry the Fowler eſtabliſhed margraves, or governors of the frontiers, to keep the barbarians in awe. The firſt margrave of Brandenburg was Sigefroy, brother-in-law to the above-mentioned emperor; under whoſe adminiſtration the biſhoprics of Brandenburg and Havelberg were eſtabliſhed by Otho I. From this Sigefroy, to the ſucceſſion of the houſe of Hohenzollern, from whom the preſent elector is deſcended, there are reckoned eight different families, who have been margraves of Brandenburg; namely, the family of the Saxons, of Walbeck, Staden, Plenck, Anhalt, Bavaria, Luxemburg, and Miſnia. The margraves of the four firſt races had continual wars with the Vandals and other barbarous people; nor could their ravages be ſtopped till the reign of Albert ſurnamed *the Bear*, the firſt prince of the houſe of Anhalt. He was made margrave by the emperor Conrad III. and afterwards raiſed to the dignity of elector by Frederic Barbaroſſa, about the year 1100. Some years afterwards the king of the Vandals dying without iſſue, left the Middle Marche by his laſt will to the elector, who was beſides poſſeſſed of the old March, Upper Saxony, the country of Anhalt, and part of Luſace. In 1332 this line became extinct, and the electorate devolved to the empire. It was then given by the emperor Louis of Bavaria to his ſon Louis, who was the firſt of the ſixth race. Louis the Roman ſucceeded his brother; and as he alſo died without children, he was ſucceeded by Otho, his third brother, who ſold the electorate to the emperor Charles IV. of the houſe of Luxemburg, for 200,000 florins of gold. Charles IV. gave the Marche to his ſon Winceſlaus, to whom Sigiſmund ſucceeded. This elector, being embarraſſed in his circumſtances, ſold the New Marche to the knights of the Teutonic order. Joſſe ſucceeded Sigiſmund; but aſpiring to the empire, ſold the electorate to William duke of Miſnia; who, after he had poſſeſſed it for one year, ſold it again to the emperor Sigiſmund. In 1417, Frederic VI. burgrave of Nuremberg, received the inveſtiture of the country of Brandenburg at the diet of Conſtance from the hands of the emperor Sigiſmund; who, two years before, had conferred upon him the dignity of elector, and arch-chamberlain of the Holy Roman empire.

This prince, the firſt of the family of Hohenzollern, found himſelf poſſeſſed of the Old and Middle Marche, but the dukes of Pomerania had uſurped the Marche Ukraine. Againſt them, therefore, the elector immediately declared war, and ſoon recovered the province. As the New Marche ſtill continued in the hands of the Teutonic knights, to whom it had been ſold as we have already mentioned, the elector, to make up for this, took poſſeſſion of Saxony, which at that time happened to be vacant by the death of Albert the laſt elector of the Anhalt line. But the emperor, not approving of this ſtep, gave the inveſtiture of Saxony to the duke of Miſnia; upon which Frederic voluntarily deſiſted from his acquiſitions. This elector made a diviſion of his poſſeſſions by will. His eldeſt ſon was deprived of his right on account of his having too cloſely applied himſelf to ſearch for the philoſopher's ſtone; ſo he left him only Voigtland. The electorate was given to his ſecond ſon Frederic; Albert, ſurnamed *Achilles*, had the duchies of Franconia; and Frederic, ſurnamed the *Fat*, had the Old Marche; but by his death it returned to the electorate of Brandenburg.

Frederic I. was ſucceeded by his ſon, called alſo *Frederic*, and ſurnamed *Iron-tooth* on account of his ſtrength. He might with as great reaſon have been ſurnamed *the Magnanimous*, ſince he refuſed two crowns, viz. that of Bohemia, which was offered him

* N° 27, &c.

Pruſſia. by the pope, and the kingdom of Poland to which he was invited by the people; but Frederic declared he would not accept of it unleſs Caſimir brother to Ladiſlaus the late king refuſed it. Theſe inſtances of magnanimity had ſuch an effect on the neighbouring people, that the ſtates of Lower Luſatia made a voluntary ſurrender of their country to him. But as Luſatia was a fief of Bohemia, the king of that country immediately made war on the elector, in order to recover it. However, he was ſo far from being ſucceſsful, that, by a treaty of peace concluded in 1462, he was obliged to yield the perpetual ſovereignty of Corbus, Peits, Sommerfeld, and ſome other places, to the elector. Frederic then, having redeemed the New Marche from the Teutonic order for the ſum of 100,000 florins, and ſtill further enlarged his dominions, reſigned the ſovereignty in 1469 to his brother Albert, ſurnamed *Achilles*.

6 Exploits of Albert ſurnamed *Achilles*.

Albert was 57 years old when his brother reſigned the electorate to him. Moſt of his exploits, for which he had the ſurname of *Achilles*, had been performed while he was burgrave of Nuremberg. He declared war againſt Lewis duke of Bavaria, defeated, and took him priſoner. He gained eight battles againſt the Nurembergers, who had rebelled and conteſted his rights to the burgraviate. In one of theſe he fought ſingly againſt 16 men, till his people came up to his aſſiſtance. He made himſelf maſter of the town of Greiffenburg in the ſame manner that Alexander the Great took the capital of the Oxydracæ, by leaping from the top of the walls into the town, where he defended himſelf ſingly againſt the inhabitants till his men forced the gates and reſcued him. The confidence which the emperor Frederic III. placed in him, gained him the direction of almoſt the whole empire. He commanded the Imperial armies againſt Lewis the Rich duke of Bavaria; and againſt Charles the Bold duke of Burgundy, who had laid ſiege to Nuis, but concluded a peace at the interpoſition of Albert. He gained the prize at 17 tournaments, and was never diſmounted.

7 Pruſſia and Brandenburg united.

All theſe exploits, however, had been performed before Albert obtained the electorate. From that time we meet with no very important tranſactions till the year 1594, when John Sigiſmund of Brandenburg, having married Anne the only daughter of Albert duke of Pruſſia, this united that duchy to the electorate, to which it has continued to be united ever ſince; and obtained pretenſions to the countries of Juliers, Berg, Cleves, Marck, Ravenſburg, and Ravenſtein, to the ſucceſſion of which Anne was heireſs.

8 Unfortunate reign of the elector George William.

Sigiſmund died in 1619, and was ſucceeded by his ſon George William; during whoſe government the electorate ſuffered the moſt miſerable calamities. At this time it was that the war commenced between the Proteſtants and Catholics, which laſted 30 years. The former, although leagued together, were on the point of being utterly deſtroyed by the Imperialiſts under the command of Count Tilly and Wallenſtein, when Guſtavus Adolphus of Sweden turned the ſcale in their favour, and threatened the Catholic party with utter deſtruction *. But by his death at the battle of Lutzen, the fortune of war was once more changed. At laſt, however, peace was concluded with the emperor; and, in 1640, the elector died, leaving his dominions to his ſon Frederic William, ſurnamed the *Great*.

* See *Sweden*.

Pruſſia. This young prince, though only 20 years of age at the time of his acceſſion, applied himſelf with the utmoſt diligence to repair the loſſes and devaſtations occaſioned by the dreadful wars which had preceded. He received the inveſtiture of Pruſſia perſonally from the king of Poland, on condition of paying 100,000 florins annually, and not making truce or peace with the enemies of that crown. His envoy likewiſe received the inveſtiture of the electorate from the emperor Ferdinand III. The elector then thought of recovering his provinces from thoſe who had uſurped them. He concluded a truce for 20 years with the Swedes, who evacuated the greateſt part of his eſtates. He likewiſe paid 140,000 crowns to the Swediſh garriſons, which ſtill poſſeſſed ſome of his towns; and he concluded a treaty with the Heſſians, who delivered up a part of the duchy of Cleves; and obtained of the Hollanders the evacuation of ſome other cities.

9 Reign of Frederic William the Great.

In the mean time, the powers of Europe began to be weary of a war which had continued for ſuch a length of time with ſuch unrelenting fury. The cities of Oſnaburg and Munſter being choſen as the moſt proper places for negociation, the conferences were opened in the year 1645; but, by reaſon of the multiplicity of buſineſs, they were not concluded till two years after. France, which had eſpouſed the intereſts of Sweden, demanded that Pomerania ſhould be ceded to that kingdom as an indemnification for the expences which the war had coſt Guſtavus Adolphus and his ſucceſſors. Although the empire and the elector refuſed to give up Pomerania, it was at laſt agreed to give up to the Swedes Hither Pomerania, with the iſles of Rugen and Wollin, alſo ſome cities; in return for which ceſſion, the biſhoprics of Halberſtadt, Minden, and Camin, were ſecularized in favour of the elector, of which he was put in poſſeſſion, together with the lordſhips of Hochenſtein and Richenſtein, with the reverſion of the archbiſhopric of Magdeburg. This was the treaty of Weſtphalia concluded in 1648, and which ſerves as a baſis to all the poſſeſſions and rights of the German princes. The elector then concluded a new treaty with the Swedes, for the regulation of limits, and for the acquittal of ſome debts, of which Sweden would only pay a fourth; and next year the electorate, Pomerania, and the duchies of Cleves, were evacuated by the Swedes.

10 Treaty of Weſtphalia concluded.

11 The elector ſucceeds againſt the Swedes.

Notwithſtanding all theſe treaties, however, the Swedes ſoon after invaded Pomerania, but were entirely defeated by the elector near the town of Fehrbellin. Three thouſand were left dead on the ſpot, among whom were a great number of officers; and a great many were taken priſoners. The elector then purſued his victory, gained many advantages over the Swedes, and deprived them of the cities of Stralſund and Gripſwald. On this the Swedes, hoping to oblige the elector to evacuate Pomerania, which he had almoſt totally ſubdued, invaded Pruſſia, from Livonia, with 16,000 men; and advancing into the country, they burned the ſuburbs of Memel, and took the cities of Tilſe and Inſterburg. The elector, to oppoſe the invaders, left Berlin on the 10th of January 1679, at the head of 9000 men. The Swedes retired at his approach, and were greatly haraſſed by the

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the troops on their march. So ſucceſsful indeed was the elector on this occaſion, that the Swedes loſt almoſt one half of their army killed or taken priſoners. At laſt, having croſſed the bay of Friſch-haff and Courland on the ice, he arrived on the 19th of January, with his infantry, within three miles of Tilſe, where the Swedes had their head-quarters. The ſame day, his general, Trefenfeldt, defeated two regiments of the enemy near Splitter; and the Swedes who were in Tilſe abandoned that place, and retired towards Courland. They were purſued by General Gortz, and entirely defeated with ſuch ſlaughter, that ſcarce 3000 of them returned to Livonia. Yet, notwithſtanding all theſe victories, the elector, being preſſed on the other ſide by the victorious generals of France, M. Turenne and the prince of Conde, was obliged to make peace with the Swedes. The conditions were, that the treaty of Weſtphalia ſhould ſerve for a baſis to the peace; that the elector ſhould have the property of the cuſtoms in all the ports of Further Pomerania, with the cities of Camin, Gartz, Grieffenburg, and Wildenbruck: on his part, he conſented to give up to the Swedes all that he had conquered from them, and to give no aſſiſtance to the king of Denmark, upon condition that France delivered up to him his provinces in Weſtphalia, and paid him 300,000 ducats, as an indemnification for the damages done by the French to his ſtates. This treaty was ſtyled *the peace of St Germain.*

12 Is obliged to conclude a treaty of peace with them.

13 A ſtrange embaſſy from the cham of Tartary.

With the treaty of St Germain terminated the military exploits of Frederic William, who paſſed the laſt years of his adminiſtration in peace. His great qualities had rendered him reſpected by all Europe, and had even been heard of in Tartary. He received an embaſſy from Murad Geray, cham of the Tartars, courting his friendſhip. The barbarian ambaſſador appeared in ſuch tattered clothes as ſcarce covered his nakedneſs, ſo that they were obliged to furniſh him with other clothes before he could appear at court. His interpreter had a wooden noſe and no ears. In 1684, Frederic received into his dominions great numbers of Proteſtants who fled out of France from the perſecutions of Louis XIV. after he had revoked the edict of Nantz. Twenty thouſand of them are ſaid to have ſettled at this time in the electorate, where they introduced new arts and manufactures, that were of the utmoſt benefit to the country. By this, however, he diſobliged Louis XIV. for which reaſon he concluded an alliance with the emperor; and having furniſhed him with 8000 troops againſt the Turks in Hungary, the emperor yielded to him the circle of Schwibus in Sileſia, as an equivalent for all his rights in that province.

14 Frederic III. obtains the title of king of Pruſſia.

In 1688, the elector Frederic William died, and was ſucceeded by his ſon Frederic III. This prince was remarkably fond of ſhow and ceremony, which, during the courſe of his government, involved him in much expence. The regal dignity ſeemed to be the greateſt object of his ambition. To obtain this, he joined with the emperor in the alliance againſt France, in which he was engaged by William III. king of Britain. He alſo yielded up the circle of Schwibus, which had been given to his predeceſſor; and, in 1700, obtained from the emperor that dignity which he had ſo earneſtly deſired. The terms on which it was obtained were, 1. That Frederic ſhould never ſeparate from the empire thoſe provinces of his dominions which depended on it. 2. That he ſhould not, in the emperor's preſence, demand any other marks of honour than thoſe which he had hitherto enjoyed. 3. That his Imperial majeſty, when he wrote to him, ſhould only give him the title of *Royal Dilection.* 4. That nevertheleſs the miniſters which he had at Vienna ſhould be treated like thoſe of other crowned heads. 5. That the elector ſhould maintain 6000 men in Italy at his own expence, in caſe the emperor ſhould be obliged to make war on account of the ſucceſſion of the houſe of Bourbon to the crown of Spain. 6. That thoſe troops ſhould continue there as long as the war laſted.

Thus was the kingdom of Pruſſia eſtabliſhed through the friendſhip of the emperor, with whom Frederic I. ſo called as being the firſt king of Pruſſia, continued all his life in ſtrict alliance. Indeed he was a pacific prince; and though contemptible in his perſon, and incapable of atchieving great things, had this merit, that he always preſerved his dominions in peace, and thus conſulted the true intereſt of his ſubjects much more than thoſe monarchs who have dazzled the eyes of the world by their military exploits. He was indeed vain, and fond of ſhow, as we have already obſerved; but had a good heart, and is ſaid never to have violated his conjugal vow; though it does not appear that he was greatly beloved by his royal conſorts (of whom he had three) on that or any other account.

15 Frederic II. of Pruſſia a martial prince.

Frederic I. died in the beginning of 1713, and was ſucceeded by Frederic William. He was in almoſt every thing the reverſe of his father. His diſpoſitions were altogether martial; ſo that he applied himſelf entirely to the augmentation of his army, and perfecting them in their exerciſe, by which means they became the moſt expert ſoldiers in Europe. His foible was an ambition of having his army compoſed of men above the ordinary ſize; but as theſe could not be procured, he compoſed a regiment of the talleſt men he could find; and as his officers made no ſcruple of picking up ſuch men wherever they could find them for his majeſty's uſe, the neighbouring ſtates were frequently offended, and a war was often likely to enſue even from this ridiculous cauſe. However, his Pruſſian majeſty was never engaged in any martial enterpriſe of conſequence: but having put his army on the moſt reſpectable footing of any in the world, and filled his coffers, for he was of a very ſaving diſpoſition, he put it in the power of his ſon to perform thoſe exploits which have been matter of aſtoniſhment to all Europe.

16 Enmity between Pruſſia and Auſtria.

It was in this king's reign that Pruſſia firſt perceived her natural enemy and rival to be the houſe of Auſtria, and not France as had been formerly ſuppoſed. Hence frequent bickerings took place between theſe two powers, for which the perſecution of the Proteſtants by ſome of the Catholic ſtates of the empire afforded a pretence; and though a war never actually took place, yet it was eaſy to ſee that both were mortal enemies to each other. But when Frederic William died in 1740, this enmity broke out in full force. The empreſs queen was then left in a very diſagreeable ſituation, as has been obſerved under the article Britain, n° 410, &c. Of this Frederic II. took the advantage to do himſelf juſtice, as he ſaid, with regard

17 Frederic II. ſeizes Sileſia.

to

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to Sileſia, of which his anceſtors had been unjuſtly deprived. This province he ſeized at that time: but it coſt him dear; for the empreſs, having at laſt overcome all difficulties, formed againſt him the moſt terrible combination that ever was known in Europe.

The treaty was hardly concluded with the king of Pruſſia, by which ſhe reluctantly yielded up the province of Sileſia, and with it a clear revenue of L. 800,000 a-year, before ſhe entered into another with the court of Peterſburg, which was concluded May 22. 1746. This treaty, as far as it was made public, was only of a defenſive nature; but ſix ſecret and ſeparate articles were added to it. By one of theſe it was provided, that in caſe his Pruſſian majeſty ſhould attack the empreſs queen, or the empreſs of Ruſſia, or even the republic of Poland, it ſhould be conſidered as a breach of the treaty of Dreſden, by which Sileſia was given up. It was alſo ſtipulated, that, notwithſtanding that treaty (which indeed had been dictated by the king of Pruſſia himſelf), the right of the empreſs-queen to Sileſia ſtill continued, and for the recovery of that province the contracting powers ſhould mutually furniſh an army of 60,000 men. To this treaty, called the treaty of *Peterſburg*, the king of Poland was invited to accede; but he, being in a manner in the power of the king of Pruſſia, did not think proper to ſign it: however, he verbally acceded to it in ſuch a manner, that the other parties were fully convinced of his deſign to co-operate with all their meaſures; and in conſideration of this intention, it was agreed that he ſhould have a ſhare in the partition of the king of Pruſſia's dominions, in caſe of a ſucceſsful event of their enterpriſes.

18 Combination againſt him.

In conſequence of theſe machinations, every art was uſed to render the king of Pruſſia perſonally odious to the empreſs of Ruſſia; the queen of Hungary made vaſt preparations in Bohemia and Moravia; and the king of Poland, under pretence of a military amuſement, drew together 16,000 men, with whom he occupied a ſtrong poſt at Pirna. The queen of Hungary, ſtill further to ſtrengthen herſelf, concluded a treaty with the court of France at Verſailles, dated May 1. 1756. But in the mean time, the king of Pruſſia having underſtood by his emiſſaries what was going forward, reſolved to be beforehand with his enemies, and at leaſt to keep the war out of his own country; and therefore

19 He invades Saxony,

entered Saxony with a conſiderable army. At firſt he affected only to demand a free paſſage for his troops, and an obſervance of the neutrality profeſſed by the king of Poland; but, having good reaſons to doubt this neutrality, he demanded, as a preliminary, that theſe Saxon troops ſhould immediately quit the ſtrong poſt they occupied, and diſperſe themſelves. This demand was refuſed; on which his Pruſſian majeſty blockaded the Saxon camp at Pirna, reſolving to reduce it by famine, ſince its ſtrong ſituation rendered an attack very dangerous. At that time there were in Bohemia two Saxon armies, one under the command of M. Brown, and the other under M. Picolomini. To keep theſe in awe, the king had ſent M. Schwerin with an army into Bohemia from the country of Glatz, and M. Keith had penetrated into the ſame kingdom on the ſide of Miſnia. But ſtill the king of Pruſſia did not entirely confide in theſe diſpoſitions;

and therefore fearing leſt M. Brown might afford ſome aſſiſtance to the Saxons, he joined his forces under Keith, and on December 1. attacked and defeated the Auſtrian general, ſo that the latter found it impoſſible to relieve the Saxons, who, after a vain attempt to retire from their poſt, were all taken priſoners. The king of Poland quitted his dominions in Germany, and the Pruſſians took up their winter-quarters in Saxony. Here they ſeized on the revenues, levied exorbitant contributions, and obliged the country to furniſh them with recruits. The king of Pruſſia at this time made himſelf maſter of the archives of Dreſden, by which means he procured the originals of thoſe pieces above-mentioned, which, when produced to the world, gave a full proof of the combination that had been formed againſt him, and conſequently juſtified the meaſures he had taken for his own defence.

Pruſſia.

20 And takes 16,000 Saxons priſoners.

No ſooner had the king entered Saxony, in the manner already related, than a proceſs was commenced againſt him in the emperor's Aulic council, and before the diet of the empire, where he was ſoon condemned for contumacy, and put to the ban of the empire.—The various circles of the empire were ordered to furniſh their contingents of men and money to put this ſentence in execution; but theſe came in ſo ſlowly, that, had it not been for the aſſiſtance of the French under the prince de Soubiſe, the army would probably have never been in a condition to act. The Auſtrians, in the mean time, made great preparations, and raiſed 100,000 men in Bohemia, whom they committed to the care of prince Charles of Lorrain, aſſiſted by M. Brown. The Czarina ſent a body of 60,000 men under M. Apraxin, to invade the Ducal Pruſſia; whilſt a ſtrong fleet was equipped in the Baltic, in order to co-operate with that army. The king of Sweden alſo acceded to the confederacy, in hopes of recovering the poſſeſſions in Pomerania which his anceſtors had enjoyed; and the duke of Mecklenburg took the ſame party, promiſing to join the Swediſh army with 6000 men as ſoon as it ſhould be neceſſary. On the king of Pruſſia's ſide appeared nobody excepting an army of between 30,000 and 40,000 Hanoverians commanded by the duke of Cumberland; and theſe were outnumbered and forced to yield to a ſuperior army of French commanded by M. D'Etrees.

21 He is proſecuted in the Aulic council, and put to the ban of the empire.

22 Prodigious preparations againſt him.

In the mean time, his Pruſſian majeſty, finding that he muſt depend for aſſiſtance ſolely on his own abilities, reſolved to make the beſt uſe of his time. Accordingly, in the ſpring 1757, his armies poured into Bohemia from two different quarters, while the king himſelf prepared to enter it from a third. M. Schwerin entered from Sileſia; the prince of Bevern from Luſatia, where he defeated an army of 28,000 Auſtrians that oppoſed his paſſage. As the intentions of the king himſelf were not known, the Auſtrians detached a body of 20,000 men from their main army to obſerve his motions. This was no ſooner done than the king cut off all communication between the detachment and the main body; and having joined his two generals with incredible celerity, he engaged the Auſtrians near Prague, totally defeated them, took their camp, military cheſt, and cannon; but loſt the brave general Schwerin, who was killed at the age of 82, with a colonel's ſtandard in his hand. On the Auſtrian

23 He invades Bohemia, and totally defeats the Auſtrian army.

ſide

Pruſſia.

ſide, M. Brown was wounded, and died in a ſhort time, though it is ſuppoſed more from the chagrin he ſuffered, than from the dangerous nature of the wound itſelf.

24 Beſieges and bombards Prague.

About 40,000 of the Auſtrian army took refuge in Prague, while the reſt fled different ways. The city was inſtantly inveſted by the king, and all ſuccours were cut off. The great number of troops which it contained rendered an attack unadviſable, but ſeemed to render the reduction of it by famine inevitable; however, the king, to accompliſh his purpoſe the more ſpeedily, prepared to bombard the town. On the 29th of May, after a moſt dreadful ſtorm of thunder and lightning, four batteries began to play on the city. From theſe were thrown, every 24 hours, 288 bombs, beſides a vaſt number of red-hot balls, ſo that it was ſoon on fire in every quarter. The garriſon made a vigorous defence, and one well-conducted ſally; but had the misfortune to be repulſed with great loſs. The magiſtrates, burghers, and clergy, ſeeing their city on the point of being reduced to an heap of rubbiſh, ſupplicated the commander in the moſt earneſt manner to capitulate; but he was deaf to their intreaties, and drove 12,000 of the moſt uſeleſs mouths out of town, who were quickly driven in again by the Pruſſians.

25 Count Daun takes the command of the Auſtrian army.

Thus the affairs of the empreſs queen ſeemed verging to deſtruction, when Leopold count Daun took upon him the command of the remains of M. Brown's army. This general had arrived within a few miles of Prague the day after the great battle. He immediately collected the ſcattered fugitives with the greateſt diligence, and retired with them to a ſtrong poſt in the neighbourhood, from whence he gave the troops in Prague hopes of a ſpeedy relief. It was now the king of Pruſſia's buſineſs, either to have attempted to make himſelf maſter of the city by one deſperate effort, or entirely to have abandoned the enterpriſe, and driven count Daun from his poſt before his troops had recovered from the terror of their late defeat; but, by attempting to do both, he rendered himſelf incapable

26 Defeats the Pruſſians at Colin.

of doing either. Though the army of count Daun already amounted to 60,000 men, and though they were ſtrongly entrenched, and defended by a vaſt train of artillery, his majeſty thought proper to ſend no more than 32,000 men. This body made the arduous attempt on the 18th of June; but though they did all that human courage and conduct could do, and though the king himſelf at laſt charged at the head of his cavalry, the Pruſſians were driven out of the field with great loſs. This engagement was named *the battle of Colin*.

27 Siege of Prague raiſed.

The firſt conſequence of the battle of Colin was, that the king of Pruſſia was obliged to raiſe the ſiege of Prague; ſoon after which, he was obliged to quit Bohemia, and take refuge in Saxony. The Auſtrians haraſſed him as much as poſſible; but, notwithſtanding their great ſuperiority, their armies were not in a condition to make any deciſive attempt upon him, as the frontiers of Saxony abounded with ſituations eaſily defended. In the mean time, the Ruſſians, who had hitherto been very dilatory in their motions, began to exert themſelves, and enter Ducal Pruſſia, under M. Apraxin and Fermor, where they committed innumerable cruelties and exceſſes. A large body of Auſtrians entered Sileſia, and penetrated as far as Breſlau. Then they made a turn backwards, and beſieged Schweidnitz. Another body entered Luſatia, and made themſelves maſters of Zittau. An army of 22,000 Swedes entered Pruſſian Pomerania, took the towns of Anclam and Demmein, and laid the whole country under contribution. The French, too, being freed from all reſtraint by the capitulation of the duke of Cumberland at Cloſter Seven §, made their way into Halbertſtadt and the Old Marche of Brandenburg, firſt exacting contributions, and then plundering the towns. The army of the empire, being reinforced by that of the prince de Soubiſe, after many delays, was on full march to enter Saxony, which left the Auſtrians at liberty to exert the greateſt part of their force in the reduction of Sileſia. General Haddick penetrated through Luſatia, paſſed by the Pruſſian armies, and ſuddenly appeared before the gates of Berlin, which city he laid under contribution. He retired on the approach of a body of Pruſſians; yet he ſtill found means to keep ſuch a poſt as interrupted the king's communication with Sileſia. The deſtruction of the king of Pruſſia therefore now ſeemed inevitable. Every exertion which he had made, though brave and well-conducted, had been unſucceſsful. His general Lehwald, who oppoſed the Ruſſians, had orders to attack them at all events. He obeyed his orders; and with 30,000 men attacked 60,000 of the enemy ſtrongly entrenched at a place called *Norkitten*. The Pruſſians behaved with the greateſt valour; but after having killed five times more of the enemy than they themſelves loſt, they were obliged to retire, though more formidable after their defeat than the Ruſſians after their victory. The king, in the mean time, exerted himſelf on every ſide, and his enemies fled everywhere before him; but whilſt he purſued one body, another gained upon him in ſome other part, and the winter came on faſt, while his ſtrength decayed, and that of his adverſaries ſeemed to increaſe on every quarter.

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§ See BRITAIN, n° 441.

28 Berlin laid under contribution.

29 Lehwald a Pruſſian general defeated by the Ruſſians.

The Pruſſian monarch, however, though diſtreſſed, did not abandon himſelf to deſpair, or loſe that wonderful preſence of mind which has ſo eminently diſtinguiſhed him in all his military enterpriſes. He induſtriouſly delayed a deciſive action till the approach of winter; but at laſt, after various movements, on November 5. 1757, he met at Roſbach with the united army of his enemies commanded by the prince of Saxe Hilburghauſen and the prince de Soubiſe. The allied army amounted to 50,000 men complete; but moſt of the troops of the Circles were new-raiſed, and many of them not well affected to the cauſe. The Pruſſians did not exceed 25,000 men; but they were ſuperior to any troops in the world, and were inſpired, by the preſence of their king, with the moſt enthuſiaſtic valour. The Auſtrians were defeated with the loſs of 3000 killed, eight generals, 250 officers of different ranks, and 6000 private ſoldiers, taken priſoners, while night alone prevented the total deſtruction of the army.

30 The king gains a great victory at Roſbach.

By this battle the king was ſet free on one ſide; but this only gave him an opportunity of renewing his labours on another. The Auſtrians had a great force, and now began to make a proportionable progreſs in Sileſia. After a ſiege of 16 days, they had reduced the ſtrong fortreſs of Schweidnitz, and obliged the

Pruſſia.

31 Schweidnitz taken by the Auſtrians.

32 Battle with the prince of Bevern.

the Pruſſian garriſon of 4000 men to ſurrender priſoners of war. Hearing then of the victory at Roſbach, and that the king of Pruſſia was in full march to relieve Sileſia, they reſolved to attack the Prince of Bevern in his ſtrong camp under the walls of Breſlau. They attacked the Prince's army on November 22d; but their attack was ſuſtained with the greateſt reſolution. The ſlaughter of the Auſtrians was prodigious. A great part of the enemy had retired from the field of battle, and the reſt were preparing to retire, when all at once the Pruſſian generals took the ſame reſolution. Their army had ſuffered much in the engagement, and they became apprehenſive of a total defeat in caſe their intrenchments ſhould be forced in any part; for which reaſon they quitted their ſtrong poſt, and retired behind the Oder. Two days after, the prince of Bevern, going to reconnoitre without eſcort, attended only by a groom, was taken priſoner by an advanced party of Croats, a ſmall body of whom had croſſed the Oder.

33 Breſlau taken by the Auſtrians.

On this the town of Breſlau immediately ſurrendered; where, as well as at Schweidnitz, the Auſtrians found great quantities of proviſions, ammunition, and money. All Sileſia was on the point of falling into their hands, and the Pruſſian affairs were going into the utmoſt diſtraction, when the king himſelf by a moſt rapid march paſſed through Thuringia, Miſnia, and Luſatia, in ſpite of the utmoſt efforts of the generals Haddick and Marſhal, who were placed there to oppoſe him; and, entering Sileſia on the 2d of December, joined the prince of Bevern's corps, who repaſſed the Oder to meet him. The garriſon of Schweidnitz, who, as we have already obſerved, had been made priſoners of war, alſo joined the king's army unexpectedly; and their preſence contributed not a little, notwithſtanding the ſmallneſs of their number, to raiſe the ſpirits of the whole army. They had ſubmitted to the capitulation with the greateſt reluctance; but as the Auſtrians were conducting them to priſon, they happened to receive intelligence of the victory at Roſbach: on which they immediately roſe on the eſcort that conducted them, and entirely diſperſed it; and afterwards marching in ſuch a direction as they thought might moſt readily lead them to their king, they accidentally fell in with his army.

34 Garriſon of Schweidnitz recover their liberty.

35 Count Daun defeated by the king of Pruſſia at Leuthen.

His Pruſſian majeſty now approached Breſlau; on which the Auſtrians, confiding in their ſuperiority, (for they exceeded 70,000, while the Pruſſians ſcarce amounted to 36,000), abandoned their ſtrong camp, the ſame which the prince of Bevern had formerly occupied, and advanced to give him battle. The king did not intend by any means to diſappoint them, but advanced on his part with the greateſt celerity. The two armies met on December 5th, near the village of Leuthen. Count Daun made the beſt diſpoſitions poſſible. The ground occupied by his army was a plain, with ſmall eminences in ſome parts. Theſe eminences they ſurrounded with artillery; and as the ground was alſo interſperſed with thickets, they fought to turn theſe likewiſe to their advantage. On their right and left were hills, on which they planted batteries of cannon. The ground in their front was interſected by many cauſeways; and to make the whole more impracticable, the Auſtrians had felled a great number of trees, and ſcattered them in the way. It was almoſt impoſſible at the beginning of the engagement for the Pruſſian cavalry to act, on account of theſe impediments; but, by a judicious diſpoſition made by the king himſelf, all difficulties were overcome. His majeſty had placed four battalions behind the cavalry of his right wing; foreſeeing that General Nadaſti, who was placed on the enemy's left with a corps de reſerve, deſigned to attack him in flank. It happened as he had foreſeen: that general's cavalry attacked the Pruſſian right wing with great fury; but he was received with ſuch a ſevere fire from the four battalions, that he was obliged to retire in diſorder. The king's flank then, well covered and ſupported, was enabled to act with ſuch order and vigour as repulſed the enemy. The Auſtrian artillery was alſo ſilenced by that of the Pruſſians; however, the Auſtrians continued to make a gallant reſiſtance during the whole battle. After having been once thrown into diſorder, they rallied all their forces about Leuthen, which was defended on every ſide by entrenchments and redoubts. The Pruſſians attacked them with the utmoſt impetuoſity, and at laſt became maſters of the poſt; on which the enemy fled on all ſides, and a total rout enſued. In this battle the Auſtrians loſt 6000 killed on the ſpot, 15,000 taken priſoners, and upwards of 200 pieces of cannon.

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36 Breſlau retaken.

The conſequences of this victory were very great. Breſlau was immediately inveſted, and ſurrendered on December 29th; the garriſon, amounting to 13,000 men, were made priſoners of war. The blockade of Schweidnitz was formed as cloſely as the ſeaſon of the year would permit; while detached Pruſſian parties over-ran the whole country of Sileſia, and reduced every place of leſs importance. The Ruſſians, who had ravaged and deſtroyed the country in ſuch a manner that they could not ſubſiſt in it, thought proper to retire out of the Pruſſian dominions altogether. Thus General Lehwald was left at liberty to act againſt the Swedes; and them he quickly drove out of Pruſſian Pomerania, the whole of which country he not only recovered, but alſo ſome part of Swediſh Pomerania. Thus the duchy of Mecklenburg being left quite expoſed, the king took ample vengeance on it by exacting the moſt ſevere contributions of men and money. To complete this monarch's good fortune alſo, the French, who had retired after the battle of Roſbach, were now oppoſed by the Hanoverians under Prince Ferdinand, who kept them ſo well employed, that, during the reſt of the war, the king of Pruſſia had no more trouble from them. See BRITAIN, n° 442.

37 Swedes driven out of Pomerania.

38 Schweidnitz retaken.

The beginning of the year 1758 was favourable to the arms of his Pruſſian majeſty. On the 3d of April he commenced his operations againſt Schweidnitz, and puſhed the ſiege ſo vigorouſly, that the place ſurrendered in 13 days. He then diſpoſed his forces in ſuch a manner as might beſt guard his dominions againſt his numerous enemies. For this purpoſe count Dohna commanded a body of troops on the ſide of Pomerania; another conſiderable body was poſted between Wohlau and Glogau, in order to cover Sileſia from the Ruſſians, in caſe they ſhould make their inroad that way. An army, in a little time after, was formed in Saxony, commanded by the king's brother Prince Henry. This army conſiſted of 3 battalions and 45 ſquadrons, and was deſigned to make head againſt the army of the empire; which, by great efforts

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forts made during the winter, and the junction of a large body of Austrians, was again in a condition to act. Between all these armies a ready communication was kept up by a proper choice of posts. After the reduction of Schweidnitz, the king having made a show of invading Bohemia, suddenly burst into Moravia, where in a short time he made himself master of the whole country, and on the 27th of May laid siege to Olmutz the capital. Of this M. Daun was no sooner informed, than he took his route to Moravia through Bohemia: and, though he was not in a condition to risk a battle, nor indeed would have done so unless he had had a very considerable advantage; yet, by placing himself in a strong situation where he could not be attacked, by harassing the king's troops and cutting off their convoys, he at last obliged him to abandon the enterprise. The king, however, who frequently owed a good part of his success to the impenetrable secrecy with which he covered all his designs, gave not the least hint of his intention to raise the siege of Olmutz. On the contrary, the very day before the siege was raised, the firing continued as brisk as ever; but in the night (July 1.) the whole army took the road to Bohemia in two columns, and gained an entire march upon the Austrians. Thus, notwithstanding the utmost efforts of his enemies, the Prussian army reached Bohemia with very little molestation. Here he seized upon a large magazine at Lieutomissel; defeated some corps of Austrians who had attempted to interrupt his progress; and arrived at Konigsgratz, of which he took possession, after driving from it 7000 Austrians who were intrenched there. This city and several other districts he laid under contribution: but soon after entered Silesia, and marched with the utmost rapidity to encounter the Russians, who had at that time united their forces under generals Brown and Fermor, entered the New Marche of Brandenburg, and laid siege to Custrin.

39 The king besieges Olmutz without success.

40 The Russians besiege Custrin

The king arrived at this city at a very critical period. The Russians had laid siege to it on the 15th of August; and though they were not well skilled in managing artillery, yet, by furious and unremitting discharges at random, they threw in such a number of bombs and red-hot balls, that the town was soon on fire in every quarter. Some of the wretched inhabitants were burned; others buried in the ruins of their houses, or killed by the balls which fell like hail in the streets; while many of the survivors abandoned their habitations, and fled out of the town on that side where it was not invested. The governor did every thing for the defence of the place; but as the walls were built after the old manner, it was impossible that the town could have made a defence for any length of time, especially as the principal magazine of the besieged had been blown up. The avenger of all these injuries, however, was now at hand. The king came in sight of the Russians on the 25th of August, after a march of 56 days, and beheld the country everywhere desolated, and the villages in flames by the depredations of his cruel enemy, who had raised the siege at his approach, and retired towards a neighbouring village named *Zorndorff*. At nine o'clock in the morning, a most terrible fire of cannon and mortars poured destruction on the right wing of the Russian army for two hours without intermission. The slaughter was such as might have been expected; but the Russians kept their ground with astonishing resolution, new regiments still pressing forward to supply the places of those that fell. When the first line had fired away all their charges, they rushed forward on the Prussians with their bayonets; and all at once these brave troops, though encouraged by the presence of their king, gave way and fled before an enemy already half defeated. The Russian generals ought now to have attacked with their cavalry the disordered infantry of their enemies, which would have completed the defeat, and in all probability given the finishing stroke to the king of Prussia's affairs. This opportunity, however, they lost: but the king was not so negligent; for, by a very rapid and masterly motion, he brought all the cavalry of his right wing to the centre, and falling on the Russian foot uncovered by their horse, and even disordered by their own success, they pushed them back with most miserable slaughter, at the same time that the repulsed battalions of infantry, returning to the charge, and exasperated at their late disgrace, rendered the victory no longer doubtful. The Russians were now thrown into the most dreadful confusion. The wind blew the dust and smoke into their faces, so that they could not distinguish friends from foes; they fired on each other, plundered their own baggage which stood between the lines, and intoxicated themselves with brandy: the ranks fell in upon one another; and, being thus crammed together into a narrow space, the fire of the Prussians had a full and dreadful effect, while their enemies kept up only a scattered and ineffectual fire, generally quite over their heads. Yet even in this dismal situation the Russians did not fly; but suffered themselves to be slaughtered till seven at night, when their generals having caused an attack to be made on the Prussian right wing, the attention of the enemy was drawn to that quarter, and they had time to retire a little from the field of battle to recover their order.

41 But are defeated at Zorndorff

In this engagement, which was called the *battle of Zorndorff*, the Russians lost 21,529 men, while that of the Prussians did not exceed 2000. A vast train of artillery was taken, together with the military chest, and many officers of high rank. The consequence was, that the Russian army retreated as far as Landsperg on the frontiers of Poland, and the king was left at liberty to march with his usual expedition to the relief of prince Henry of Saxony.

42 Operations of Count Daun.

The Prince was at this time sorely pressed by M. Daun. As soon as the king had left Bohemia in the manner already related, M. Daun, considering that it would have been to no purpose to follow him, resolved to turn his arms towards Saxony. Towards that country, therefore, he took his route through Lusatia, by Zittau, Gorlitz, and Bautzen. On the 3d of September he invested the strong fortress of Sonnestein; which unaccountably surrendered, after a single day's resistance, to one of his generals named *Macguire*. He then began to favour the operations of General Laudohn, who had advanced through the Lower Lusatia to the confines of Brandenburg; and, by drawing the attention of the Prussian forces which were left in Silesia to the northward of that duchy, he facilitated the progress of the generals Harsch and De Ville in the southern parts. He then proposed that prince Henry should be attacked by the army of the empire, while that of

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the Auſtrians ſhould paſs the Elbe, and, falling at the ſame time on the Pruſſians, ſecond the attack of the Imperialiſts, and cut off the retreat of their enemies from Dreſden. The ſudden appearance of the king of Pruſſia, however, put an end to this plan; general Laudohn abandoned all his conqueſts in Lower Luſatia, and retired towards M. Daun, while that general himſelf retired from the neighbourhood of Dreſden as far as Zittau. The army of the empire only kept its ground; poſſeſſing itſelf of the ſtrong poſt at Pirna, formerly mentioned, but did not undertake any thing. As for the Swedes, who had directed their motions by thoſe of the Ruſſians, they no ſooner heard of the victory of Zorndorff, than they retreated with much more expedition than they had advanced.

43 Rendered abortive by the king of Pruſſia;

Thus the king of Pruſſia's affairs ſeemed to be pretty well retrieved, when by one fatal piece of negligence he was brought to the verge of ruin. M. Daun had poſſeſſed himſelf of an advantageous camp at Stolphen, by which he preſerved a communication with the army of the empire. On the other hand, the king of Pruſſia, having taken poſſeſſion of an important poſt at Bautzen, extended his right wing to the village of Hochkirchen, by which he preſerved a communication with his brother Prince Henry, protected Brandenburg, and was better ſituated than he could be anywhere elſe for throwing ſuccours into Sileſia. The two armies kept a watchful eye on the motions of each other; and as the principal aim of M. Daun was to cut off the king's communication with Sileſia, and of the king to cut off M. Daun's communication with Bohemia, a battle ſeemed inevitable, though great danger ſeemed to await that party who ſhould begin the attack.

44 Who is ſurpriſed and defeated at Hochkirchen.

In this critical poſture of affairs, the Auſtrian general formed a deſign of attacking the Pruſſian camp in the night. In what manner he came to ſurpriſe ſuch a vigilant enemy, has never been accounted for; but that ſuch a ſurpriſe was actually accompliſhed on the 14th of October, is certain. In the dead of the preceding night, the Auſtrian army began to march in three columns towards the camp of the king of Pruſſia: and though the night was exceedingly dark, and they had a conſiderable way to go, they all arrived at the ſame time, in ſafety, without being diſcovered, and without the leaſt confuſion; and at five in the morning began a regular and well-conducted attack. The Pruſſians were in a moment thrown into confuſion; Marſhal Keith, one of their beſt generals, received two muſket-balls, and fell dead on the ſpot. Prince Francis of Brunſwick had his head ſhot off by a cannon-ball as he was mounting his horſe; and every thing ſeemed to announce the total deſtruction of the army. Still, however, the king preſerved his wonderful preſence of mind, which indeed he never appears to have loſt on any occaſion. He ordered ſome detachments from his left to ſupport his right wing; but the moment that theſe orders were received, the left itſelf was furiouſly attacked. General Ketzow, who commanded in that quarter, repulſed the Auſtrians with difficulty, and was not able to afford any conſiderable aſſiſtance to the right; which alone was obliged to ſuſtain the weight of the grand attack. The Auſtrians, in the beginning of the engagement, had driven the Pruſſians out of the village of Hochkirchen; and as the fate of the day depended on the poſſeſſion of that poſt, the hotteſt diſpute was there. The Pruſſians made three bloody and unſucceſsful attacks on the village; on the fourth they carried it; but the Auſtrians continually pouring in freſh troops, at laſt drove them out with prodigious ſlaughter on all ſides. The king then ordered a retreat, which was conducted in good order, without being purſued; however, this bloody action coſt him 7000 men, together with a great number of cannon. The Auſtrians computed their own loſs at 5000. Pruſſia.

His Pruſſian majeſty, having thus happily eſcaped ſuch imminent danger, took every poſſible meaſure to prevent the enemy from gaining any conſiderable advantage from his defeat. Perceiving that the only advantage they wiſhed to derive from it was to cover the operations of their armies in Sileſia, and that he had now nothing to fear on the ſide of Saxony, he largely reinforced his own army from that of Prince Henry, and haſtened into Sileſia, in order to raiſe the ſiege of Neiſs, which had been completely inveſted on the 4th of October. On the 24th of that month, therefore, he quitted his camp, and, making a great compaſs, to avoid obſtructions from the enemy, arrived in the plains of Gorlitz. A body of the Auſtrians had in vain attempted to ſecure this poſt before him, and ſome who arrived after him were defeated with the loſs of 800 men. From this place the king purſued his march with the utmoſt diligence; but was followed by general Laudohn, at the head of 24,000 men, who conſtantly hung on his rear, and haraſſed his army. The king, however, knowing the importance of his expedition, continued his march without interruption, and ſuffered his antagoniſt to obtain many little advantages without moleſtation. Daun, however, not content with the oppoſition given by Laudohn, ſent a large body of horſe and foot by another route to reinforce the generals Karſch and De Ville, who had formed the ſiege of Neiſs and the blockade of Coſel, while he himſelf paſſed the Elbe, and advanced towards Dreſden.

All theſe precautions, however, were of little avail. The generals Karſch and De Ville, notwithſtanding their reinforcement, no ſooner heard of the king of Pruſſia's approach, than they raiſed the ſiege of both places, and retired, leaving behind them a conſiderable quantity of military ſtores. The end of the Pruſſian monarch's march being thus accompliſhed, he inſtantly returned by the ſame way he came, and haſtened to the relief of Saxony, the capital of which (Dreſden) was in great danger from Marſhal Daun. The place was but indifferently fortified, and garriſoned only by 12,000 men; ſo that it could not promiſe to hold out long againſt a numerous and well-appointed army. It was beſides commanded by a large ſuburb, of which, if once the enemy got poſſeſſion, all defence of the city muſt then be vain. For this reaſon M. Schmettau, the Pruſſian governor, determined to ſet theſe ſuburbs on fire, which was actually done November 10th, with an incredible loſs to the inhabitants, as in the ſuburbs were carried on moſt of thoſe valuable manufactures which render the city of Dreſden remarkable. This diſappointed the deſigns of M. Daun; but, though the action was agreeable to the laws of war, and had been executed with all the caution and humanity of which ſuch an action was capable, yet the Auſtrians exclaimed againſt it as a piece of the moſt unprovoked and wanton cruelty recorded in hiſtory.

45 Suburbs of Dreſden burnt.

After

Prussia.

46 Saxony oppressed by the king of Prussia.

After the king of Prussia had approached Dresden, all the Austrian armies retired into Bohemia, where they took up their winter-quarters, as the king of Prussia did in Saxony. This unhappy country he said he would now consider as his own by right of conquest. But instead of treating the conquered people as his lawful subjects, he oppressed them in all possible ways, by levying the most severe and exorbitant contributions, surrounding the exchange with soldiers, and confining the merchants in narrow lodgings on straw-beds, till they drew upon their correspondents for such sums as he wanted.

In 1759, as early as the 23d of February, the Prussians commenced their military operations. General Woberson marched with a body of troops into Poland, where he destroyed several very large magazines belonging to the Russians, and returned into Silesia without any loss on the 18th of April. In the mean time, by some movements of the king of Prussia himself, the greatest part of the Austrian troops had been drawn towards the frontiers of Silesia. Prince Henry immediately took advantage of this opening, and on the 15th of April entered Bohemia with his army divided into two columns. One, commanded by himself, marched towards Peterswade; the other, under general Hulsen, passed by the towns of Pasberg and Commottau. That commanded by Prince Henry himself penetrated as far as Loboschutz and Leitmeritz; the enemy flying everywhere before them, and burning or abandoning the vast magazines which they had amassed in these parts. The body under general Hulsen had a more active employment. A strong pass at Pasberg was defended by a considerable body of Austrians. General Hulsen, having conducted his cavalry by another way in such a manner as to fall directly on their rear, attacked them in front with his infantry, drove them out of their intrenchments, and totally defeated them with the loss of a great number killed, and 2000 taken prisoners, while that of the Prussians did not exceed 70 in killed and wounded. After this exploit they returned into Saxony, with hostages for the contributions which they had largely exacted during the course of their expedition.

47 Bohemia invaded by Prince Henry.

48 A body of Austrians defeated by General Hulsen.

Some other successes obtained by Prince Henry, cleared the country of Franconia of his enemies; but now the approach of the Russians seemed once more to bring the affairs of the king of Prussia to a crisis. Notwithstanding the destruction of their magazines, they had continued to advance into Silesia, where they were opposed by Count Dohna; but as the troops he had with him were very far inferior to his enemies, he found it impossible to do more, at least with any appearance of success, than to observe their motions and harass them on their march. But this was so displeasing to the king, that he disgraced this general, and appointed Wedel to succeed him, with orders to attack the Russians at all events. To enable him, however, in some measure to comply with this desperate order, he sent him some reinforcements, which brought his army up to near 30,000. With these, on the 23d of July 1759, General Wedel attacked 70,000 Russians posted in the most advantageous manner at Zulichau, and defended by a numerous artillery. Though the Prussians marched on to certain destruction and disgrace, they sustained the attack for a long time with unparalleled resolution. At last, however, they gave way, and were obliged to retire with the loss of 4700 killed or taken prisoners, and 3000 wounded.

49 Prussians defeated at Zulichau.

Prussia.

50 The Russians take Crossen and Frankfort on the Oder.

The consequences of this victory were, that the Russians penetrated into the king's territories, and took possession of the towns of Crossen and Frankfort on the Oder, which made it absolutely necessary for the king to come in person to oppose them. Accordingly, on the 4th of August, he joined Wedel with a considerable body of forces, having left the greatest part of his army in Saxony under Prince Henry. But as Marshal Daun had sent a body of 12,000 horse and 8000 foot under General Laudohn to the assistance of the Russians, the king still found himself unable to fight them; as, with this and some other reinforcements, their army now amounted to upwards of 90,000. He therefore recalled General Finck, whom he had sent into Saxony with 9000 men; but, with all his reinforcements, it was found impossible to augment his army to 50,000 complete. His situation, however, was now so critical, that a battle was unavoidable; and therefore, on the 12th of August, with this inferiority of number, the king attacked his enemies strongly intrenched, and defended by a prodigious number of cannon. In this action, his principal effort was against the left wing of the Russian army. He began the attack, according to custom, with a heavy cannonade; which having produced the desired effect, he attacked that wing with several battalions disposed in columns. The Russian intrenchments were forced with great slaughter, and 72 pieces of cannon were taken. But still there was a defile to be passed, and several redoubts which covered the village of Cunnersdorf to be mastered. These were attacked with the same resolution, and taken one after another. The enemy made another stand at the village, and endeavoured to preserve their ground there by pushing forward several battalions of horse and foot: but this also proved unsuccessful; they were driven from post to post quite to the last redoubts. For upwards of six hours the Prussians were successful, and everywhere broke the enemy with prodigious slaughter; drove them from almost all the ground they had occupied before the battle, took more than half their artillery, and scarce any thing seemed wanting to make the victory complete. In these circumstances, the king wrote the following billet to the queen: "Madam, we have beat the Russians from their intrenchments. In two hours expect to hear of a glorious victory." Of this victory, however, he deprived himself, by an excessive eagerness for conquest. The enemy, defeated almost in every quarter, found their left wing, shattered as it was, to be more entire than any other part of their army. Count Soltikoff, the Russian general, therefore assembled the remains of his right wing, and, gathering as many as he could from his centre, reinforced the left, and made a stand at a redoubt which had been erected on an advantageous eminence in a place called *the Jews burying-ground*. All the king's generals are said to have been of opinion, that he ought to allow the Russians the peaceable possession of this post. Their army had already suffered so much, that it would have been impossible for them to have attempted any enterprise of consequence after the battle; but their artillery was still numerous, the post very strong, and the Prussian troops greatly fatigued. These reasons for a few mo-

51 King of Prussia defeated by the Russians at Cunnersdorf.

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ments had ſome weight with the king: but the natural impetuoſity of his temper getting the better of his reaſon, he led on his wearied troops again and again; till at laſt, when their ſtrength was in a manner totally exhauſted, they were attacked and utterly routed by the Auſtrian and Ruſſian cavalry, the former of which had hitherto remained quite inactive, and were therefore quite freſh, and irreſiſtible by the enfeebled Pruſſians. The night, and the prudent uſe of ſome eminences, prevented the total deſtruction of the army; however, their loſs amounted to 20,000 men killed and wounded. The king, when he found the victory totally loſt, ſent another billet to the queen, expreſſed in the following manner: "Remove from Berlin with the royal family; let the archives be carried to Potſdam; the town may make conditions with the enemy."

Immediately after this defeat, the king ſet himſelf about repairing his loſſes with the utmoſt diligence. In a few days every thing was again put in order in his camp. He replaced his artillery from Berlin; recalled General Klieſt with 5000 men from Pomerania; detached 6000 from his own army to the defence of Saxony; and with the remainder put himſelf between the Ruſſians and Great Glogau, covering that city which had been the chief object of their deſigns; and in ſhort, notwithſtanding their victory, obliged them to return to Poland without accompliſhing any thing beſides the carnage at Cunnerſdorff.

The misfortunes of the Pruſſian monarch, however, were not at an end. Prince Henry indeed, by a moſt extraordinary and well-conducted march, entered Saxony, which was now totally over-run by the armies of the enemy. At the ſame time, ſtrong detachments having been ſent into that country under generals Finck and Wunſch, the whole was in a ſhort time recovered except Dreſden. Towards this place Marſhal Daun retired, and in all probability would ſoon have been obliged to leave Saxony entirely. But the king's impatience could not be ſatisfied without cutting off his retreat, and forcing him to a battle; for which purpoſe he ſent General Finck with upwards of 12,000 men according to the Pruſſian account, but 20,000 according to the Auſtrians, to ſeize ſome paſſes through which M Daun could only take his route towards Bohemia. This commiſſion was executed with great exactneſs; but the Pruſſian general, having probably advanced too far into theſe defiles, and neglected to preſerve a communication with the main army, gave his enemy an opportunity of ſurrounding him, and at laſt forcing him and his whole army to ſurrender priſoners of war. This diſaſter was ſoon after followed by another. General Durceke was poſted at the right of the Elbe, oppoſite to Meſſen; but on the approach of a large body of Auſtrians, they prepared to retreat over the river into a place where they hoped to be more ſecure. But having been obliged by an hard froſt to withdraw their bridge of boats, a thaw ſupervened, when they attempted to lay a bridge of pontoons, ſo that they were again obliged to have recourſe to their boats. In this ſituation, their rear-guard was attacked with great fury by the Auſtrians, and all the ſoldiers who compoſed it killed or taken. The loſs of the Pruſſians on this occaſion was computed at 3000 men.

52 General Finck with 12,000 Pruſſians ſurrenders to the Auſtrians.

The year 1760 ſhowed the Pruſſian monarch in a more dangerous ſituation than he had ever yet experienced. Indeed his affairs now ſeemed to be altogether deſperate. His loſſes were not to be meaſured by the number of the killed or priſoners, but by armies deſtroyed or taken. Forty generals had died or been killed in his ſervice ſince the beginning of October 1756, excluſive of thoſe who were wounded or taken priſoners. This of itſelf would have been an irreparable loſs, had not the very wars which deſtroyed theſe furniſhed others equally capable of filling their places. But another deficiency, which could not be remedied, ſtill remained.—The king had, by his indefatigable induſtry and exertions, ſupplied all the deficiencies of men in his armies, but they were not the ſame men as before. The hardy veterans, with whom he had originally taken the field, were now no more, and their places were ſupplied by others who had neither the ſame experience nor diſcipline; ſo that now he was obliged to ſupply this deficiency by his own genius and heroiſm.

Pruſſia.

53 Deſperate ſituation of the king of Pruſſia.

But whatever abilities the Pruſſian monarch might poſſeſs, and though he undoubtedly exerted them to the utmoſt, it ſeemed only to be contending againſt fate, and his enemies gained ſtill greater and greater advantages. General Laudohn, with whom none but the king himſelf ſeems to have been able to cope, by a ſeries of artful movements, drew into a diſadvantageous ſituation M. Fouquet, one of the Pruſſian generals, with a ſtrong body of forces. Perceiving it impoſſible for them to eſcape, Laudohn then made a violent attack on their intrenchments in the dead of the night of June 23d. The Pruſſians made a gallant defence, but at laſt were all killed or taken priſoners except about 300. Of the Pruſſians were killed 4000, and 7000 taken priſoners; 58 pieces of cannon, and a great number of colours, were alſo loſt. The victory, however, was dear bought; for the Auſtrians loſt above 12,000 men in killed and wounded; whom, however, they could better ſpare than the Pruſſians, on account of their numbers.—This action was called *the battle of Landſhut*.

54 Pruſſians defeated at Landſhut.

Baron Laudohn failed not to improve this victory to the utmoſt. He inſtantly turned back from Landſhut, and fell upon the city of Glatz; which he took in a very ſhort time, with the garriſon who defended it, conſiſting of 2000 men. In this place were found 101 pieces of braſs cannon, with immenſe quantities of proviſions and military ſtores. From thence he marched againſt Breſlau, and immediately inveſted it. But, in the mean time, the king of Pruſſia, whoſe motions had been all this time counteracted by M. Daun in Saxony, marched with his uſual rapidity towards Sileſia. By this means he drew M. Daun out of Saxony; and indeed the Auſtrian general uſed ſuch expedition, that he gained two full days on the king. This was no ſooner known to his Pruſſian majeſty, than he returned with the ſame expedition that he had advanced, and ſat down before Dreſden. Of this M. Daun ſoon received intelligence, and returned alſo. In the mean time, however, the buildings of the city were terribly ſhattered by the king's cannon and bombs which continually played on it. His endeavours, however, proved ineffectual to reduce it before the arrival of M. Daun. The ſiege had been begun on the 13th of July, and on the 19th M. Daun appeared within a league of Dreſden. The

55 Glatz taken by the Auſtrians.

56 Dreſden beſieged but without ſucceſs by the king of Pruſſia.

Pruſſia. Pruſſians then redoubled their efforts. They had that day received reinforcements of heavy cannon and mortars, with which they battered the place inceſſantly. The cathedral church, New Square, ſeveral principal ſtreets, and ſome palaces, and the noble manufactory of porcelain, were entirely deſtroyed. The ſiege was continued till the 22d: but, on the night of the 21ſt, M. Daun had thrown 16 battalions into the city; which rendered it impoſſible for the king to continue longer before it with any proſpect of ſucceſs. He therefore raiſed the ſiege, and retired without moleſtation, though there were three conſiderable armies of the enemy in the neighbourhood. Breſlau was fiercely bombarded by Laudohn, but the approach of Prince Henry obliged him to deſiſt from his enterpriſe on the 5th of Auguſt.

But, in the mean time, the fortune of the king ſeemed likely to be terminated by one fatal ſtroke. Finding it impoſſible for him to carry on a defenſive war, he marched towards Sileſia with ſuch aſtoniſhing rapidity, that before the middle of Auguſt he had advanced 200 miles, leaving Marſhal Daun with his army far behind him. This expedition he undertook in order to engage General Laudohn before he could have time to effect a junction with Daun and Lacy, another Auſtrian general; which triple union ſeemed to threaten him with unavoidable deſtruction at once. This, however, he found it impoſſible to prevent: and the three armies, when joined, formed a moſt tremendous line of encampments, extending no leſs than 30 Engliſh miles; at the ſame time that every one of their poſts was ſtrong, and the communication between them eaſy. The king was ſtrongly encamped at Lignitz; and for ſeveral days employed all his military ſkill in attempting to induce one of the bodies to detach itſelf from the reſt, or to attack them at ſome diſadvantage; but without effect. At laſt, the Auſtrian generals, having maturely weighed all circumſtances, reſolved to attack the king's camp itſelf, ſtrong as it was; and Marſhal Daun, remembering the advantage he had gained at Hochkirchen by an attack in the night-time, reſolved to follow the ſame plan now. The plan therefore was laid in the following manner. The whole army, as ſoon as it ſhould begin to grow dark, was to march from their ſeveral poſts to ſuch ſituations as were marked out for each corps: they were to ſtrike their tents, but yet to keep up the fires in their camps, and to have the drums beat the tattoo as uſual, by which means they had a probability of ſurpriſing the enemy; or if not, they judged it abſolutely impoſſible for him to eſcape them, though he ſhould be ever ſo much on his guard. In what manner the king of Pruſſia became acquainted with this plan, is not known. His friends attributed it to his own penetration and knowledge of the ſtratagems of war; the Auſtrians, to intelligence given him by deſerters. But, in whatever way he became acquainted with this deſign, it is certain that he took the moſt effectual methods of preventing it. As the Auſtrian plan was to ſurround his camp, and this could not be done without the diviſion of their army which he had ſo long deſired, he reſolved to intercept one of the parties; and if that ſhould be diſabled from acting, he could then more eaſily deal with the other two. Therefore, in the very evening calculated for the deciſive attack on his camp, he quitted it with the utmoſt privacy, and took an advantageous poſt on the road through which General Laudohn was to paſs. The nature of this poſt was ſuch, that at the ſame time that it ſtopped the progreſs of Laudohn in front, Daun would lie under great difficulties if he ſhould attempt his rear; at the ſame time that, for his further ſecurity, the king ſtrengthened the rear with ſeveral batteries. As ſoon as his army was drawn up, he divided it; leaving his right on the ground where it had been formed, to obſerve Marſhal Daun, and to maintain that poſt; whilſt with his left he turned in order to fall on the corps under General Laudohn. In the mean time, that commander, ignorant of the fate which was awaiting him, advanced with the utmoſt expedition towards the place which had been aſſigned him, in order to ſhare in the glory of deſtroying the Pruſſian monarch; when, at three in the morning, on the 15th of Auguſt, a thick fog which covered the ground, ſuddenly clearing up, diſcovered, like the opening of a great ſcene, the dreadful front of the Pruſſian army regularly embattled, and advantageouſly poſted. Laudohn, though ſurpriſed, made the beſt diſpoſitions that circumſtances would admit of, and an obſtinate engagement enſued; in which, however, he was at laſt obliged to yield to the ſuperior ſkill of his adverſary, with the loſs of 10,000 killed, wounded, and priſoners, 82 pieces of cannon, and 23 pair of colours. Pruſſia.

57 Three Auſtrian generals join their forces againſt him.

58 He defeats General Laudohn, and intimidates the Ruſſians.

The victory, though complete, gave but a partial relief to the king of Pruſſia. The moſt eſſential ſervice it did was the preventing of the Ruſſians from joining thoſe enemies which he already had. Count Czernichew had been advancing with 24,000 men, and had even paſſed the Oder; but was ſo intimidated by this news, that he inſtantly repaſſed that river on the ſame bridges which he had lately built, even though M. Daun ſent him a ſtrong body of troops in order to encourage him to advance. Soon after this battle, the king joined his brother Prince Henry at New Marche; and marched againſt Daun, who had begun to form the blockade of Schweidnitz, fell upon a corps under General Beck, made two battalions of Croats priſoners, and diſperſed the reſt, which obliged the enemy to abandon the enterpriſe they had juſt undertaken. About the ſame time, General Hulſen gained a conſiderable advantage over the Imperial army in Saxony, with very trifling loſs on his part, by which he effectually prevented them from cutting off his communication with the city of Torgau.

By theſe ſucceſſes the affairs of his Pruſſian majeſty ſeemed to revive: but there was no end of his enemies. The late manœuvres had drawn him ſo far into Sileſia, that his communication with Brandenburg was almoſt wholly cut off. The Ruſſian army, which after it had repaſſed the Oder began to move out of Sileſia, ſent forward a powerful detachment under Count Czernichew towards the march of Brandenburg. A body of 15,000 Auſtrians, under the generals Lacy and Brentano, and the whole united body of Auſtrians and Imperialiſts which acted in Saxony, began their march in concert with the Ruſſians, and propoſed to unite at the gates of Berlin. Theſe armies amounted to 40,000 men. To oppoſe this formidable power, general Hulſen called to his aſſiſtance general Werner, who had been ſent with a body of troops into Pomerania;

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rania; but, after being joined by him, their united forces were found not to exceed 15,000 or 16,000 men. To attempt a defence of the capital with this force would have been little ſhort of madneſs: and therefore theſe commanders were obliged to leave Berlin to its fate; which indeed, conſidering the barbarity of the Ruſſians and the animoſity of the Auſtrians, ſeemed to be a dreadful one. However, by the powerful mediation of ſeveral foreign miniſters, the town obtained terms which were not altogether intolerable; but the magazines, arſenals, and founderies were deſtroyed, and an immenſe quantity of military ſtores ſeized, with a number of cannon and other arms. The city was firſt obliged to pay 800,000 guilders, after which a contribution of 1,900,000 crowns was laid on: yet, notwithſtanding this, many violences were committed, and the king's palace was plundered and the furniture abuſed in a ſcandalous manner.

59 Berlin taken by the Auſtrians and Ruſſians.

The combined armies ſtaid in Berlin only four days; dreading the ſevere vengeance of the king of Pruſſia, who they heard was advancing towards that place with great expedition. But ſo great were the embarraſſments which now attended that monarch, that it ſeemed abſolutely beyond human power to retrieve his affairs. The Imperialiſts, on their return from Berlin, having no army to oppoſe them, made themſelves maſters of Leipſic, Torgau, Meiſſen, and Wirtemberg; in which laſt city they found the grand magazine of the Pruſſians immenſely ſtored with proviſions, ammunition, &c. M. Stainville alſo, with a detachment from Broglio the French general's army, laid the city and duchy of Halberſtadt under contribution. In Eaſtern Pomerania, the Ruſſians had beſieged Colberg by ſea and land. In the Weſtern Pomerania, the Swedes advanced with great celerity, hoping to ſhare in the plunder of Berlin. In Sileſia, the king no ſooner began his march to the northward, than Laudohn advanced, and laid ſiege to the important fortreſs of Coſel; and, to complete this diſtreſs and embarraſſment, the king himſelf was attended at every ſtep by Count Daun with a ſuperior army well prepared to take every advantage.

60 Extreme embarraſſment of the king.

In this deſperate ſituation the king, being joined by his generals Hulſen and prince Eugene of Wittemberg with the corps under their command, advanced up the Elbe, while M. Daun fell back to cover Leipſic and Torgau: but the latter, finding that the Pruſſians directed their march towards the Elbe, encamped within reach of Torgau; one part of his army extending to the Elbe, by which he was covered on that ſide, whilſt on the other he was covered by hills and woods, ſo that it was impoſſible to chooſe a more advantageous ſituation. The Pruſſian army did not amount to 50,000 men, whilſt that of the Auſtrians exceeded 86,000: yet ſuch were the unfortunate circumſtances of the king, that he was obliged to fight under all theſe diſadvantages; and therefore he cauſed his army to be informed, that he was now to lead them to a moſt deſperate attempt, that his affairs required it, and that he was determined to conquer or die. His ſoldiers unanimouſly declared that they would die with him.

61 He defeats Count Daun at Torgau.

The 3d of November 1760 was the day on which this important affair was decided. The king divided his forces into three columns. General Hulſen was to take poſt with one in a wood that lay on the left of the Auſtrian army, and had orders not to move until he found the reſt of the Pruſſians engaged. General Ziethen was to charge on the right; and the great attack in front was to be conducted by the king in perſon. His forces were diſpoſed in ſuch a manner, that either his right or left muſt take the enemy in rear and cloſe them in, ſo as to diſable them from undertaking any thing againſt the part where he intended to effect his principal attack. On the other hand, M. Daun perceiving the king to be ſerious in his deſign of fighting, to prevent confuſion, ſent all his baggage over the Elbe, acroſs which he threw three bridges in caſe a retreat ſhould be neceſſary. At the ſame time he cauſed Torgau to be evacuated; and then, extending his firſt line to a village called *Zinne* on the left, he ſtretched it to another called *Croſwitz* on the right; ſupporting the right of his ſecond line upon the Elbe. In this diſpoſition he was found, when, about two o'clock in the afternoon, the king began his attack. He was received by the fire of 200 pieces of cannon, which were diſpoſed along the Auſtrian front. The Pruſſians were thrice led on to the attack; but were every time repulſe. and broken with terrible ſlaughter. The king at length commanded a freſh body of cavalry to advance, which at firſt compelled the Auſtrians to retire; but new reinforcements continually coming in, this cavalry was in its turn obliged to fall back, and the Pruſſians maintained themſelves with extreme difficulty, until General Ziethen, with the right wing, attacked the enemy in the rear, repulſed them, and poſſeſſed himſelf of ſome eminences which commanded the whole Auſtrian army. Encouraged by this ſucceſs, the Pruſſian infantry once more advanced, maſtered ſeveral of the enemy's intrenchments, and made way for a new attack of their cavalry, which broke in with irreſiſtible fury on the Auſtrians, and threw ſeveral bodies of them into irreparable diſorder. It was now about 9 o'clock, and of conſequence both armies were involved in thick darkneſs; yet the fire continued without intermiſſion, and the battalions with a blind rage diſcharged at one another without diſtinguiſhing friend from foe. M. Daun received a dangerous wound in the thigh, and was carried from the field, which probably haſtened the defeat of his troops. The command then devolved on Count O'Donnell; who, finding the greateſt part of his troops in diſorder, the night advanced, and the enemy poſſeſſed of ſome eminences which commanded his camp, and from which it was in vain to think of driving them, ordered a retreat, which was conducted with wonderful order and exactneſs; none were loſt in paſſing the bridges, and by far the greater part of their artillery was preſerved. The loſs of the Pruſſians was eſtimated at 10,000 killed and wounded, and 3000 taken priſoners. That of the Auſtrians in killed and wounded is not known; but 8000 were taken priſoners, with 216 officers, among whom were four generals.

62 All Saxony except Dreſden recovered.

The conſequence of the victory of Torgau was, that the king recovered all Saxony except Dreſden; and in the mean time General Werner having marched into Pomerania, the Ruſſians raiſed the ſiege of Colberg, and retired into Poland, without having effected any thing further than waſting the open country. Werner then flew to the aſſiſtance of Weſtern Pomerania, where he defeated a body of Swedes, and at laſt drove them totally out of the country. General Laudohn too abruptly raiſed the blockade of Coſel; and afterwards, abandoning

Pruſſia. abandoning Landſhut, he retired into the Auſtrian Sileſia, leaving the Pruſſian part entirely in quiet. M. Daun placed one part of his army in Dreſden, and the other in ſome ſtrong poſts which lie to the ſouth and weſt of it, by which he commanded the Elbe, and preſerved his communication with Bohemia. The army of the empire retired into Franconia, and placed its headquarters at Bamberg.

Though theſe ſucceſſes had, to appearance, retrieved the king's affairs in ſome meaſure, yet his ſtrength ſeemed now to be wholly exhauſted; and in the campaign of 1761, he made no ſuch vigorous efforts as he had formerly done. The Ruſſians, dividing themſelves into two bodies, invaded Sileſia and Pomerania. In the former country they laid ſiege to Breſlau, and in the latter to Colberg. Tottleben alſo, who had commanded the Ruſſian armies, was now removed on a ſuſpicion that he had correſponded with the king of Pruſſia, and general Romanzow put in his place; by which it was expected that the Ruſſian operations would be more briſk this year than formerly.

The king continued ſtrongly encamped near Schweidnitz; where he was ſo cloſely watched by generals Daun and Laudohn, that he could attempt nothing. However, he defeated the deſigns of the Ruſſians againſt Breſlau, by ſending general Platen to deſtroy their magazines; which he accompliſhed with great ſucceſs, at the ſame time cutting off a body of 4000 of their troops. But this only brought the more ſure deſtruction upon Colberg; to which place that body of Ruſſians immediately marched, cruelly waſting the country as they went along. The king of Pruſſia could do nothing but ſend detachments of ſmall parties, which, though they could not oppoſe their enemies in the field, yet he hoped, by cutting off the convoys of the enemy, might diſtreſs them to ſuch a degree as to oblige them to abandon the ſiege, or at leaſt protract it till the ſeverity of the winter ſhould render it impoſſible for them to carry on their operations. Thus he weakened his own army ſo much, that it was found requiſite to draw 4000 men out of Schweidnitz in order to reinforce it; and no ſooner was this done, than general Laudohn ſuddenly attacked and took that fortreſs by a coup de main. Colberg made a brave defence; but the troops ſent to its relief being totally unable to cope with the Ruſſian army conſiſting of 50,000 men, it was obliged to ſurrender on the 3d of December; and thus the fate of the Pruſſian monarch ſeemed to be decided, and almoſt every part of his dominions lay open to the invaders.

63 Schweidnitz and Colberg retaken.

64 Empreſs of Ruſſia dies.

In the midſt of theſe gloomy appearances the empreſs of Ruſſia, the king's moſt inveterate and inflexible enemy, died on the 2d of January 1762. Her ſucceſſor, Peter III. inſtead of being the king's enemy, was his moſt ſanguine friend. As early as the 23d of February, in a memorial delivered to the miniſters of the allied courts, he declared, that, "in order to the eſtabliſhment of peace, he was ready to ſacrifice all the conqueſts made in this war by the arms of Ruſſia, in hopes that the allied courts will on their parts equally prefer the reſtoration of peace and tranquillity, to the advantages which they might expect from the continuance of the war, but which they cannot obtain but by a continuance of the effuſion of human blood."—This addreſs was not ſo well reliſhed by the allies: however, they were very willing to make peace, provided it was for their own intereſt; but they reccommended to his attention fidelity to treaties, which conſtitutes a no leſs valuable part of the royal character, than humanity and diſintereſtedneſs. This anſwer made no impreſſion on the czar; a ſuſpenſion of hoſtilities took place on the 16th of March, which was followed by a treay of alliance on the 5th of May. In this treaty the czar ſtipulated nothing in favour of his former confederates; on the contrary, he agreed to join his troops to thoſe of the king of Pruſſia, in order to act againſt them. Sweden, which had for a long time acted under the direction of Ruſſian counſels, now followed the example of her miſtreſs, and concluded a peace with Pruſſia on the 22d of May.

Pruſſia.

65 Peace between Ruſſia, Sweden, and Pruſſia.

66 Succeſſes of the king of Pruſſia.

It is not to be ſuppoſed that the king of Pruſſia would remain long inactive after ſuch an unexpected turn in his favour. His arms were now everywhere attended with ſucceſs. Prince Henry drove the Imperialiſts from ſome important poſts in Saxony, by which he ſecured all that part which the Pruſſians poſſeſſed; and though the Auſtrians frequently attempted to recover theſe poſts, they were conſtantly repulſed with great ſlaughter. The king was not joined by his new allies till the latter end of June; after which he drove M. Daun before him to the extremity of Sileſia, leaving the town of Schweidnitz entirely uncovered, and which the king immediately prepared to inveſt. In the mean time different detachments of Pruſſians, ſome on the ſide of Saxony, and others on that of Sileſia, penetrated deep into Bohemia, laid many parts of the country under contribution, and ſpread an univerſal alarm. A conſiderable body of Ruſſian irregulars alſo made an irruption into Bohemia, where they practiſed on the Auſtrians the ſame cruelties which they had long been accuſtomed to practiſe on the Pruſſians.

67 A new revolution in Ruſſia.

But while the king was thus making the beſt uſe of his time, he was all at once threatened with a fatal reverſe of fortune by a new revolution in Ruſſia. The emperor was depoſed, and his depoſition was ſoon after followed by his death. The empreſs, who ſucceeded him, ſuſpected that her huſband had been miſled by the counſels of his Pruſſian majeſty, againſt whom, therefore, ſhe entertained a mortal enmity. She could not, however, in the very beginning of her reign, undertake again a war of ſo much importance as that which had been juſt concluded. She therefore declared her intention of obſerving the peace concluded by the late emperor; but, at the ſame time, of recalling her armies from Sileſia, Pruſſia, and Pomerania; which indeed the unſettled ſtate of the kingdom now made in ſome degree neceſſary. At the ſame time a diſcovery was made with regard to the king of Pruſſia himſelf, which turned the ſcale greatly in his favour. The Ruſſian ſenate, flaming with reſentment againſt this monarch, and againſt their late unfortunate ſovereign; and the empreſs, full of ſuſpicion that the conduct of the latter might have been influenced by the councils of the former, ſearched eagerly amongſt the papers of the late emperor for an elucidation or proofs of this point. They found indeed many letters from the Pruſſian monarch; but in a ſtrain abſolutely different from what they had expected. The king had, as far as prudence would permit, kept a reſerve and diſtance with regard to the too raſh advances of this unhappy ally; and, in particular, counſelled him to undertake nothing againſt

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the empress his consort. The hearing of these letters read is said to have had such an effect upon the empress, that she burst into tears, and expressed her gratitude towards the Prussian monarch in the warmest terms. Still, however, the Russian army was ordered to separate from the Prussians; but all the important places which the former had taken during the whole war were faithfully restored.

The king, finding that the Russians were no more to take an active part in his favour, resolved to profit by their appearance in his camp; and therefore, the very day after the order for their return had arrived, he attacked the Austrian army, and drove their right wing from some eminences and villages where they were advantageously posted; by which means he entirely cut off their communication with Schweidnitz, so that nothing could be attempted for its relief. Prince Henry kept them in continual alarms for Bohemia; and a great part of their attention, and no small part of their forces, were engaged on that side. Marshal Daun, now finding himself rendered almost incapable of undertaking any thing, detached general Laudohn, with a force very much superior, to attack the prince of Bevern, and drive him from the advantageous post he occupied. But the prince defended himself with such resolution, that all the efforts of Laudohn could not succeed before the king had time to come to his assistance. The Austrians, being then put between two fires, were routed and pursued with terrible slaughter; after which, the king met with no more disturbance in his preparations for the siege, and the trenches were opened on the 18th of July. Marshal Daun made no attempts to relieve the place; but the garrison being very strong, it held out for near two months from the opening of the trenches. It is said that the attack was conducted, and the defence made, by two engineers who had written on the subject of the attack and defence of fortified places; and they were now practically engaged to prove the superiority of their systems. At last, however, the garrison, to the number of 8000 men, surrendered prisoners of war; and the whole body, except nine, were soon after drowned at the mouth of the Oder, on their passage to their intended confinement at Konigsberg.

68 General Laudohn utterly defeated.

The king of Prussia, now become master of Schweidnitz, turned his attention towards Saxony, where he considerably reinforced his brother's army, and made preparations for laying siege to Dresden. In this country the Austrians had lately met with some success, and driven Prince Henry back as far as Freyberg; but on the 29th of October, they were attacked by the Prussian army thus reinforced, and totally routed. Great numbers were slain, and near 6000 taken prisoners. This victory proved decisive: and the empress-queen, finding herself deserted by all her allies, was glad to conclude a treaty; the substance of which was, that a mutual restitution and oblivion should take place, and both parties sit down at the end of the war in the same situation in which they began it. This treaty is called the *peace of Hubertsburg*.

69 The total defeat of the Austrians at Freyberg produces a peace.

The war was no sooner concluded than the king of Prussia turned his attention to domestic policy, and the recovery of his dominions from those innumerable calamities which had befallen them during the war. He immediately distributed lands to his disbanded soldiers, and gave them the horses of his artillery to assist them in their cultivation. By his wise and prudent management, the horrors of war were soon forgot; and the country was quickly in as flourishing a state as ever. Notwithstanding this pacific disposition, however, the king never slackened his endeavours for the defence of his country, by keeping a respectable army on foot; which might be able to act on the least emergency.

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70 A new war commences, but produces no memorable event.

In the year 1778, a new difference with the house of Austria took place, concerning the duchy of Bavaria. But though the most enormous warlike preparations were made on both sides, and immense armies brought into the field, nothing of consequence was effected. What little advantage there was, seems to have been on the Prussian side, since they made themselves masters of several towns, and kept the war in the enemy's country. However, the emperor acted with so much caution, and showed so much skill in a defensive war, that all the manœuvres of his Prussian majesty could gain no material advantage; as, on the other hand, his adversary was too wise to venture an engagement. A peace therefore was very soon concluded, and since that time the history of Prussia, during the remainder of the great Frederic's reign, affords no remarkable event which we have not mentioned in the life of that hero, and in the article POLAND. He left his crown to his nephew, whose character was not then much developed; and it was easily seen that a new kingdom, which had risen suddenly to such unexampled power and greatness as to excite the jealousy or apprehension of all its neighbours, would require great abilities to preserve it from dismemberment.

71 The great Frederic succeeded by his nephew.

72 State of the nation, and behaviour of the new king.

The late king had indeed bequeathed the most effectual securities to his successor for the preservation of his dominions, that human wisdom could provide or devise; by leaving him a full treasury, the finest army in the world, and a people enthusiastically attached to his memory and government. The new monarch, with these advantages, was not wanting to himself. The late king's predilection for the French language and French literature were not grateful to his subjects. The present sovereign began his reign with declaring in council, "Germans we are, and Germans I mean we shall continue;" giving directions at the same time, that their native language should resume its natural rank and station, from which for near half a century it had been degraded by the French. This was a very popular measure, and it was followed by another still more so. Observing that he had marked with great concern the progress of impiety and profaneness on the one hand, and of enthusiasm on the other, he declared, that he would not have his subjects corrupted either by fanatics or atheists, and strictly prohibited all publications tending to excite a contempt or indifference for religion.

Such, on his immediate accession to the throne, was the pacific conduct of the monarch, which endeared him to his subjects, and commanded the approbation of all good men. An opportunity soon occurred, in which he was thought to have displayed such talents in negotiation and in military arrangements, as proclaimed him in every respect a worthy successor of his uncle. The States of Holland, who had long been jealous of the power of the Stadtholder, and inclined to a republican government without any permanent chief, had gained

73 He assists the stadtholder against the states of Holland.

Pruſſia. ed ſuch an aſcendancy in the ſtates general, that in 1786 and 1787 they in effect diveſted the prince of Orange of all his prerogatives (ſee *United Provinces*). They proceeded even to the ſeizure and impriſonment of the princeſs, ſiſter to the king of Pruſſia; and depending upon ſupport from France, treated with inſolence every power connected with them in Europe. The court of Berlin did not witneſs theſe proceedings without indignation; and the king formed his plan for reſtoring the power of the Stadtholder with ſuch ſecrecy and prudence, that perhaps nothing could ſurpaſs it but the bravery and military ſkill of the duke of Brunſwick, by whom it was carried into execution. In the ſhort ſpace of one month, that accompliſhed general led 18,000 Pruſſians to Amſterdam, and reſtored the juſt prerogatives of the prince of Orange. And here, we believe, the friends of the houſe of Brandenburg will agree with us, that our hiſtory of Pruſſia ſhould conclude. The monarch's ſubſequent conduct has not been ſuch as the beginning of his reign gave reaſon to expect. Something of it will be ſeen under the article Poland, and more under Revolution and *United Provinces*; and it is not a ſubject upon which we delight to dwell.

74 Air, ſoil, and population, of Pruſſia.

The air of Pruſſia is wholeſome, and the ſoil fruitful in grain; affording, beſides, plenty of pitcoal and other fuel. The rivers and lakes are well ſtored with fiſh; and amber is found on its coaſt towards the Baltic. The principal rivers are the Viſtula, Bregel, Memel, the Paſſarge, and the Elbe; all of which frequently do damage by their inundations.

The inhabitants of this country were, by Dr Buſching, computed at 635,998 perſons capable of bearing arms; and by another German author, at 450,000. Since the year 1719 it is computed that about 34,000 coloniſts have removed hither from France, Switzerland, and Germany; of which number one half were Saltzburgers. Theſe emigrants have built 400 ſmall villages, 11 towns, 50 new churches, and founded 1000 village-ſchools. The manners of the people differ but little from thoſe of the Germans. The eſtabliſhed religions are thoſe of Luther and Calvin, but chiefly the former; though almoſt all other ſects are tolerated.

75 Commerce and manufactures.

The late king of Pruſſia, by the aſſiſtance of an excellent police, brought the commerce and manufactures of this country to a very flouriſhing ſtate, which during his life were daily improving. The manufactures of Pruſſia conſiſt in glaſs, iron-work, paper, gunpowder, copper, and braſs-mills; manufactures of cloth, camblet, linen, ſilk, gold and ſilver lace, ſtockings, and other articles. The inhabitants export variety of naval ſtores; amber, lint-ſeed and hemp-ſeed, oat-meal, fiſh, mead, tallow, and caviar; and it is ſaid that 500 ſhips are loaded with thoſe commodities every year, chiefly from Koningſberg.

76 Conſtitution.

His Pruſſian majeſty is abſolute through all his dominions; but the late king was too wiſe to oppreſs his ſubjects, though he availed himſelf to the full of his power. How the preſent ſovereign treats them we know not, as the whole of his conduct for ſome time paſt has related to the Poliſh and French revolutions. The government of this kingdom is by a regency of four chancellors of ſtate, *viz.* 1. The great-maſter; 2. The great-burgrave; 3. The great-chancellor; and, 4. The great-marſhal. There are alſo ſome other councils, and 37 bailiwicks. The ſtate conſiſts, 1. Of counſellors of ſtate; 2. Of deputies from the nobility; and, 3. From the commons. Beſides theſe inſtitutions, the late king erected a board for commerce and navigation. Pruſſia || Prynne.

77 Revenues.

His Pruſſian majeſty, by means of the happy ſituation of his country, its inland navigation, and the excellent regulations of his predeceſſor, derives an amazing revenue from this country, which, about a century and a half ago, was the ſeat of boors and barbariſm. It is ſaid, that amber alone brings him in 26,000 dollars annually. His other revenues ariſe from his demeſnes, his duties of cuſtoms and tolls, and the ſubſidies yearly granted by the ſeveral ſtates; but the exact ſum is not known, though we may conclude that it is very conſiderable, from the immenſe charges of the late war.

78 Military ſtrength.

The military regulations introduced by the late king had a wonderfully quick operation in forming his troops and reeruiting his armies. Every regiment has a particular diſtrict aſſigned it, where the young men proper for bearing arms are regiſtered; and when occaſion offers, they join their regiment, and being incorporated with veterans they ſoon become well diſciplined troops. The Pruſſian army, in time of peace, conſiſts of 175,000 of the beſt diſciplined troops in the world; and during the laſt war, that force was augmented to 300,000 men.

79 Royal arms, &c.

The royal arms of Pruſſia are argent, an eagle diſplayed ſable, crowned, or, for Pruſſia: azure, the Imperial ſceptre, or, for Courland: argent, an eagle diſplayed, gules, with ſemicircular wreaths, for the marquiſate of Brandenburg: to theſe are added the reſpective arms of the ſeveral provinces ſubject to the Pruſſian crown.

There are two orders of knighthood; the firſt, that of the Black Eagle, inſtituted by Frederic I. on the day of his coronation at Koningſberg, with this motto, *Suum cuique*. The ſovereign is always grand-maſter; and the number of knights, excluſive of the royal family, is limited to 30. Next to this is the order of Merit, inſtituted by his late majeſty; the motto is, *Pour le merite*.

PRUSSIAN blue. See Chemistry-*Index*, at *Colouring Matter* and *Pruſſian Blue*.

PRUSSIC acid, according to M. Berthollet, is a combination of azot of hydrogene and carbon. It appears much leſs akin to acids than to ammoniac; it has, however, too many properties in common with other acids not to place it in the ſame claſs, the rather becauſe our claſſifications are always in a degree arbitrary, and ought to be conſidered rather as uſeful methods, than as diviſions formed by nature. When the Pruſſic acid is combined with alkali and oxyd of iron, it cannot be ſeparated by any other acid, unleſs heat be employed, or it be expoſed to light; and nevertheleſs, when it is diſengaged by one of theſe means, it cannot ſeparate iron, even from the weakeſt acid, unleſs it be by a double affinity. It appears that this property is connected with the elaſtic ſtate, which is unfavourable to theſe combinations: it muſt have loſt this ſtate, in other words its ſpecific heat muſt be diminiſhed, in order that it may poſſeſs its affinities with metallic oxyds and alkalis. Nitrous gas, oxygenated muriatic acid, and ſulphureous acid, preſent analogous phenomena. *Chemical Annals*, vol. i. p. 19, &c.

PRYNNE (William), an Engliſh lawyer, much diſtinguiſhed

Prynne ‖ Pſalmanazar.

diſtinguiſhed in the civil commotions under Charles I. was born at Swainſwick in Somerſetſhire in 1600. His *Hiſtriomaſtix*, written againſt ſtage-plays in 1632, containing ſome reflections that offended the court, he was ſentenced by the ſtar-chamber to pay a fine of 5000 l. to ſtand in the pillory, to loſe his ears, and to perpetual impriſonment. During his confinement, he wrote ſeveral more books; particularly, in 1637, one entitled *News from Ipſwich*, which reflecting ſeverely on the biſhops, he was again ſentenced by the ſtar-chamber to another fine of 5000 l. to loſe the remainder of his ears in the pillory, to be branded on both cheeks with S. L. for ſeditious libeller, and to be perpetually impriſoned in Caernarvon caſtle. Nothing but cutting off his hands could have prevented Prynne from writing: he wrote ſtill; and in 1640, being ſet at liberty by the houſe of commons, he entered London in a kind of triumph, was elected into parliament for Newport in Cornwall, and oppoſed the biſhops with great vigour, being the chief manager of archbiſhop Laud's trial. In the long parliament he was zealous in the Preſbyterian cauſe; but when the Independents gained the aſcendency, he oppoſed them warmly, and promoted an agreement with the king. When the army garbled the houſe and refuſed him entrance, he became a bitter enemy to them and their leader Cromwell, and attacked them with his pen ſo ſeverely, that he was again impriſoned: but he pleaded the liberty of the ſubject ſo ſucceſsfully, that he was enlarged, to write more controverſial books. Being reſtored to his ſeat after Cromwell's death, with the other ſecluded members, he aſſiſted in promoting the reſtoration, and was appointed keeper of the Tower records; a place excellently well calculated for him, and where he was very uſeful by the collections he publiſhed from them. He preſented 40 volumes of his works, in folio and 4to, to Lincoln's-inn library, of which ſociety he was a member; and, dying in 1669, was buried under the chapel.

PRYTANES, in Grecian antiquity, were the preſidents of the ſenate, whoſe authority conſiſted chiefly in aſſembling the ſenate; which, for the moſt part, was done once every day.

The ſenate conſiſted of 500, 50 ſenators being elected out of each tribe: after which, lots were caſt, to determine in what order the ſenators of each tribe ſhould preſide; which they did by turns, and during their preſidentſhip were called *prytanes*. However, all the 50 prytanes of the tribes did not govern at once, but one at a time, viz. for ſeven days; and after 35 days, another tribe came into play, and preſided for other five weeks; and ſo of the reſt.

PSALM, a divine ſong or hymn; but chiefly appropriated to the 150 Pſalms of David, a canonical book of the Old Teſtament.

Moſt of the pſalms have a particular title, ſignifying either the name of the author, the perſon who was to ſet it to muſic or ſing it, the inſtrument that was to be uſed, or the ſubject and occaſion of it. Some have imagined that David was the ſole author of the Book of Pſalms; but the titles of many of them prove the contrary, as pſalm xix. which appears to have been written by Moſes. Many of the pſalms are inſcribed with the names *Korah*, *Jeduthun*, &c. from the perſons who were to ſing them.

PSALMANAZAR (George), the fictitious name of a pretended Formoſan, a perſon of learning and ingenuity. He was born in France, and educated in a free-ſchool, and afterwards in a college of Jeſuits, in an archiepiſcopal city, the name of which, as likewiſe thoſe of his birth-place and of his parents, are unknown. Upon leaving the college, he was recommended as a tutor to a young gentleman; but ſoon fell into a mean rambling life, that involved him in diſappointments and misfortunes. His firſt pretence was that of being a ſufferer for religion. He procured a certificate that he was of Iriſh extraction, that he left that country for the ſake of the Catholic faith, and was going on a pilgrimage to Rome. Being unable to purchaſe a pilgrim's garb, and obſerving one in a chapel, dedicated to a miraculous ſaint, which had been ſet up as a monument of gratitude by ſome wandering pilgrim, he contrived to take both the ſtaff and cloak away; and, being thus accoutred, begged his way in fluent Latin, accoſting only clergymen or perſons of figure; whom he found ſo generous and credulous, that, before he had gone 20 miles, he might eaſily have ſaved money, and put himſelf in a much better dreſs: but as ſoon as he had got what he thought was ſufficient, he begged no more; but viewed every thing worth ſeeing, and then retired to ſome inn, where he ſpent his money as freely as he had obtained it. Having heard the Jeſuits ſpeak much of China and Japan, he ſtarted the wild ſcheme, when he was in Germany, of paſſing for a native of the iſland of Formoſa; and what he wanted in knowledge, he ſupplied by a pregnant invention. He formed a new character and language on grammatical principles, which, like other oriental languages, he wrote from right to left with great readineſs; and planned a new religion, and a diviſion of the year into 20 months, with other novelties, to credit his pretenſions. He was now a Japaneſe convert to Chriſtianity, travelling for inſtruction, with an appearance more wretched than even that of common beggars. He then entered as a ſoldier in the Dutch ſervice: but, ſtill deſirous of paſſing for a Japaneſe, he altered his plan to that of being an unconverted heathen; and at Sluys, brigadier Lauder, a Scots colonel, introduced him to the chaplain, who, with a view of recommending himſelf to the biſhop of London, reſolved to carry him over to England. At Rotterdam, ſome perſons having put ſhrewd queſtions to him, that carried the air of doubt, he took one more whimſical ſtep, which was to live upon raw fleſh, roots, and herbs; which ſtrange food he thought would remove all ſcruples. The biſhop of London patronized him with credulous humanity; and Pſalmanazar found a large circle of friends, who extolled him as a prodigy. Yet were there ſome who entertained a juſt opinion of him, particularly the Drs Halley, Mead, and Woodward; but their endeavours to expoſe him as a cheat only made others think the better of him, eſpecially as thoſe gentlemen were eſteemed no great admirers of revelation. But in this inſtance at leaſt, eaſineſs of belief was no great evidence of penetration. He was employed to tranſlate the church-catechiſm into the Formoſan language, which was examined, approved, and laid up as a valuable MS; and the author, after writing his well-known *Hiſtory of Formoſa*, was rewarded and ſent to Oxford to ſtudy what he liked, while his patrons and opponents were learnedly diſputing at London on the merits of his work. The learned

Pſalmanazar.

members

Pſalmiſt || Pſatyrians.

members of the univerſity were no better agreed in their opinions than thoſe at London; but at length the ſceptics triumphed. Some abſurdities were diſcovered in his hiſtory, of ſuch a nature as to diſeredit the whole narration, and ſaved him the trouble of an open declaration of his impoſture; which however he owned at length to his private friends. For the remainder of his life, his learning and ingenuity enabled him to procure a comfortable ſupport by his pen; he being concerned in ſeveral works of credit, particularly *The Univerſal Hiſtory*. He lived irreproachably for many years, and died in 1763.

PSALMIST, in the church of Rome, one of the leſſer eccleſiaſtical orders; the ſame with what among us is called *clerk*, *precentor*, or *ſinger*.

PSALMODY, the art or act of ſinging pſalms. See PSALM.

Pſalmody was always eſteemed a conſiderable part of devotion, and uſually performed in the ſtanding poſture: and as to the manner of pronunciation, the plain ſong was ſometimes uſed, being a gentle inflection of the voice, not much different from reading, like the chant in cathedrals; at other times more artificial compoſitions were uſed, like our anthems.

As to the perſons concerned in ſinging, ſometimes a ſingle perſon ſung alone; ſometimes the whole aſſembly joined together, which was the moſt ancient and general practice. At other times, the pſalms were ſung alternately, the congregation dividing themſelves into two parts, and ſinging verſe about, in their turns. There was alſo a fourth way of ſinging, pretty common in the fourth century, which was, when a ſingle perſon began the verſe, and the people joined with him in the cloſe: this was often uſed for variety, in the ſame ſervice with alternate pſalmody.

The uſe of muſical inſtruments, in the ſinging of pſalms, ſeems to be as ancient as pſalmody itſelf; the firſt pſalm we read of being ſung to the timbrel, viz. that of Moſes and Miriam, after the deliverance of the Iſraelites from Egypt: and afterwards, muſical inſtruments were in conſtant uſe in the temple of Jeruſalem. See ORGAN.

PSALTER, the ſame with the book of pſalms. See the article PSALM.

Among the religious in the Popiſh countries, the term *pſalter* is alſo given to a large chaplet or roſary, conſiſting of 150 beads, according to the number of pſalms in the pſalter.

PSALTERY, a muſical inſtrument, much in uſe among the ancient Hebrews, who called it *nebel*.

We know little or nothing of the preciſe form of the ancient pſaltery. That now in uſe is a flat inſtrument, in form of a trapezium or triangle truncated at top: it is ſtrung with 13 wire-chords, ſet to uniſon or octave, and mounted on two bridges, on the two ſides: it is ſtruck with a plectrum, or little iron rod, and ſometimes with a crooked ſtick. Its cheſt or body reſembles that of a ſpinet. See NABLUM and Plate CCCXLIV.

PSAMMETICUS, or PSAMMITICHUS, a renowned conqueror, who, ſubduing 11 other petty kings of Egypt, became the founder of the kingdom of Egypt, about 670 B. C. He is memorable likewiſe for taking the city of Azot, after a ſiege of 29 years; and for diſcovering the ſources of the river Nile. See EGYPT, n° 10.

PSATYRIANS, a ſect of Arians, who, in the council of Antioch, held in the year 360, maintained, that the Son was not like the Father as to will; that he was taken from nothing, or made of nothing; and that in God, generation was not to be diſtinguiſhed from creation.

Pſellus, Pſeudo.

PSELLUS (Michael), a learned Chriſtian of the 11th century, was, by birth, a Conſtantinopolitan of conſular rank, and flouriſhed under the emperor Conſtantine Monomachus. His genius and induſtry raiſed him far above the level of his cotemporaries; and the female hiſtorian Anna Comnena ſpeaks of him as one who had been more indebted for his attainments to his own excellent talent than to the inſtructions of his preceptors; adding, that having made himſelf maſter of all the wiſdom of the Greeks and the Chaldeans, he was juſtly eſteemed the moſt learned man of the age. Thus furniſhed, he became the chief inſtructor of the Conſtantinopolitan youth. He was at the ſame time the companion and the preceptor of the emperor, who was ſo captivated by the ſtudies and amuſements in which Pſellus engaged him, that, according to Zonaras, he neglected the concerns of the empire. The Byzantine hiſtorians complain, that the emperor, deluded by the head of the philoſophers (the title with which Pſellus was honoured), loſt the world. Meeting, towards the cloſe of his life, with ſome diſappointment, Pſellus retired into a monaſtery, and ſoon afterwards died; the time of his death is uncertain. His works, which have been much celebrated, are, Commentaries upon Ariſtotle's Logic and Phyſics; a Compendium of Queſtions and Anſwers; and an Explanation of the Chaldean Oracles. The two latter works prove him to have been converſant, not only with Grecian, but with Oriental, philoſophy. *Enfield's Hiſtory of Philoſophy.*

PSEUDO, from ψευδω, a Greek term uſed in the compoſition of many words, to denote *falſe* or *ſpurious*: as the pſeudo-acacia, or baſtard acacia; pſeudo-fumaria, or baſtard-fumitory; pſeudo-ruta, or baſtard-rue, &c.

We alſo ſay, a pſeudo-apoſtle, or falſe apoſtle; a pſeudo-prophet, or falſe prophet, &c.

PSEUDO-China. See SMILAX.

PSEUDO-Galena, or *Black-Jack*. See ZINC, and MINERALOGY, p. 62.

PSEUDO-Tinea, in natural hiſtory, the name of a very remarkable ſpecies of inſect deſcribed by M. Reaumur, approaching to the nature of the *tinea*, or *clothes-moth* while in the worm-ſtate, but not making themſelves coats of the ſubſtance of leaves, cloth, &c. though they form a ſort of caſes for their defence againſt a very terrible enemy.

Theſe creatures are of the caterpillar kind, and have, in the manner of many of theſe inſects, 16 legs. They feed on wax, and for food enter the bee-hives; where they boldly engage the bees, and are not to be prevented by them from feeding, though at the expence of their habitations and the cells of their reſervoirs of honey: ſo that it is no uncommon thing for a ſwarm of bees to be forced to change their place of habitation, and make new combs elſewhere; leaving the old ones to this contemptible victor, whom they know not how to drive out or diſpoſſeſs.

Virgil and Ariſtotle, and all the authors who have written on bees, have complained of this deſtructive animal. It never eats the honey, but feeds only on the wax; attacking principally thoſe waxy cells where-

Pſeudo.

the female bee depoſites her eggs for the future progeny.

The bees, who are a match for moſt other creatures by means of their ſtings, would eaſily deſtroy theſe weak creatures, were it not for the impervious armour they are covered with. They form themſelves a coat of armour of a double matter. The firſt, which immediately covers the body, is of a kind of ſilk of their own ſpinning; and the outer covering over this is of the bees-wax: this is laid conſiderably thick; and the creature, juſt thruſting out its head to feed, goes on devouring the cells undiſturbed, while a whole army of the inhabitants are in vain buzzing about him, and attempting to pierce him with their ſtings. He never forſakes his covering, but lengthens and enlarges it as he goes; and gnawing down the ſides of the cells in his march, without ſtaying to eat them one by one, the havock and deſtruction he occaſions are ſcarce to be conceived. When the time of the change of this creature approaches, it contracts its body within its double covering, and there changes into the nymph ſtate; whence, after a proper time, it comes forth in form of a moth, with granulated horns and a crooked proboſcis.

The bees have cunning enough to know their deſtructive enemy in this new form; and as this is a weak and defenceleſs ſtate, they attack and deſtroy all the moths of this ſpecies they can meet with. They ſeldom are ſo fortunate, however, as to kill the whole race as ſoon as produced; and if only one eſcapes, it is able to lay a foundation of revenge for the death of its brethren. All the flies of the moth kind lay a vaſt number of eggs, and this is behind hand with none of them in that particular: the young ones produced from the eggs of one ſurviving female of this ſpecies are ſufficient to deſtroy many honey-combs; nay, many hives of them. The moth produced by this caterpillar flies but little; yet it is very nimble in avoiding danger, by running, which it does with great ſwiftneſs.

There is a ſpecies of theſe pſeudo-tineæ, or wax-eating caterpillars, which infeſt the ſubterraneous hives of waſps and other creatures which make wax: the manner of living, feeding, and defending themſelves from their enemies, is the ſame in all the ſpecies. Theſe laſt, if they are at any time diſtreſſed for food, will eat their own dung; the wax having paſſed almoſt unaltered through their bodies, and being ſtill wax, and capable of affording them more nouriſhment on a ſecond digeſtion. Theſe ſpecies, though they naturally live on this ſoft food, yet if by any accident they meet with harder only, they know how to live upon it; and can eat a way into the covers and leaves of books, and make themſelves caſes and coverings of the fragments of theſe ſubſtances. The accurate author † of theſe obſervations deſcribes alſo a kind of *pſeudo-tinea* which feeds on wool, and another that eats leather; both making themſelves houſes alſo of the materials they feed on.

† *Reaumur's Hiſtory of Inſects.*

There is alſo another kind very deſtructive to corn: theſe make themſelves a covering by faſtening together a great number of the grains, and there living and eating in ſecret. All theſe creatures, whatever be their food or habitation, finally become *phalenæ*, or moths; and may be diſtinguiſhed, even in this ſtate, from the other ſpecies, by having granulated horns of a remarkable ſtructure, and all of them a proboſcis, or trunk, more or leſs incurvated.

Pſeudonymus ‖ Pſittacus.

PSEUDONYMUS, among critics, an author who publiſhes a book under a falſe or feigned name; as *cryptonymus* is given to him who publiſhes one under a diſguiſed name, and *anonymous* to him who publiſhes without any name at all.

PSIDIUM, the GUAVA: A genus of the monogynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 19th order, *Heſperideæ*. The calyx is quinquefid, ſuperior; there are five petals; the berry is unilocular and monoſpermous. There are two ſpecies: 1. The pyriferum, or white guava; 2. The pomiferum, or red guava. Both theſe are thought to be only varieties of the ſame plant. The red guava riſes to the height of 20 feet, and is covered with a ſmooth bark; the branches are angular, covered with oval leaves, having a ſtrong midrib, and many veins running towards the ſides, of a light green colour, ſtanding oppoſite upon very ſhort footſtalks. From the wings of the leaves the flowers come out upon footſtalks an inch and an half long: they are compoſed of five large roundiſh concave petals, within which are a great number of ſtamina ſhorter than the petals, and tipped with pale yellow tops. After the flower is paſt, the germen becomes a large oval fruit ſhaped like a pomegranate.

A decoction of the roots of guava is employed with ſucceſs in dyſenteries: a bath of a decoction of the leaves is ſaid to cure the itch and other cutaneous eruptions. Guayava, or guava, is diſtinguiſhed from the colour of the pulp, into the two ſpecies above-mentioned, the white and the red; and, from the figure of the fruit, into the round, and the pear-faſhioned or perfumed guava. The latter has a thicker rind, and a more delicate taſte than the other. The fruit is about the bigneſs of a large tennis-ball; the rind or ſkin generally of a ruſſet ſtained with red. The pulp within the thick rind is of an agreeable flavour, and interſperſed with a number of ſmall white ſeeds. The rind, when ſtewed, is eaten with milk, and preferred to any other ſtewed fruit. From the ſame part is made marmalade; and from the whole fruit is prepared the fineſt jelly in the world. The fruit is very aſtringent, and nearly of the ſame quality with the pomegranate; ſo ſhould be avoided by all who are ſubject to coſtiveneſs. The ſeeds are ſo hard as not to be affected by the fermentation in the ſtomachs of animals; ſo that when voided with the excrements, they take root, germinate, and produce thriving trees. Whole meadows in the Weſt Indies are covered with guavas, which have been propagated in this manner. The buds of guava, boiled with barley and liquorice, produce an excellent ptiſan for diarrhœas, and even the bloody flux, when not too inveterate. The wood of the tree, employed as fuel, makes a lively, ardent, and laſting fire.

PSITTACUS, or PARROT, in ornithology; a genus belonging to the order of *picæ*. The bill in this genus is hooked from the baſe; and the upper mandible is moveable: the noſtrils are round, placed in the baſe of the bill, which in ſome ſpecies is furniſhed with a kind of cere: the tongue is broad, and blunt at one end: the head is large, and the crown flat: the legs are ſhort, the toes placed two before and two behind. It might ſeem a wonder why nature has deſtined to this, which is not naturally a bird of prey, but feeds on fruits and vegetable ſubſtances, the crooked beak

Pſittacus. allotted to the hawk and other carnivorous birds: but the reaſon ſeems to be, that the parrot being a heavy bird, and its legs not very fit for ſervice, it climbs up and down trees by the help of this ſharp and hooked bill, with which it lays hold of any thing and ſecures itſelf before it ſtirs a foot; and beſides this, it helps itſelf forward very much, by pulling its body on with this hold.

Of all animals, the parrot and crocodile are the only ones which move the upper jaw; all creatures elſe moving the lower only. As ſome particular animals beſide are fond of particular foods, ſo the parrot loves nothing ſo much as the ſeeds of the carthamus, or baſtard-ſaffron; and eats them without any hurt, though they are a purge when given to other creatures.

Parrots are found almoſt everywhere within the tropics; and in their natural ſtate they live on fruits and ſeeds, though, when tame, they will eat fleſh, and even fiſh.

In the Eaſt and Weſt Indies they are very common, and in ſuch warm climates are very briſk and lively; here, however, they loſe much of their vigour. They ſeldom make neſts, but breed like owls in hollow trees; they lay two eggs. At particular times they fly in very large troops, but ſtill they keep two and two together. This genus conſiſts of infinite variety, not ſo much owing to mixture of ſpecies, however, as might be ſuppoſed. They ſeem to run vaſtly into one another, ſo as to appear to be related, though received from different parts of the world; this, however, may poſſibly be occaſioned by their being carried from one place to another for the ſake of ſale. This uncertainty of native place has prevented Mr Latham from following Buffon's plan, and ranging them according to the places they are ſuppoſed to inhabit; he divides them therefore into thoſe with *uneven* and thoſe with *even* tails.

Buffon ranges the parrots in two great claſſes: the firſt of which comprehends thoſe of the Old Continent, and the ſecond thoſe of the New. The former he ſubdivides into five families, the Cockatoos, the Parrots, properly ſo called, the Lories, the long-tailed Paroquets, and the ſhort-tailed ones; and the latter into ſix, viz. the Macaos, the Amazonians, the Creeks, the Popinjays, the long-tailed Paroquets, and the ſhort-tailed ones.

Mr Latham has increaſed the genus from 47 to 163; and ſince the time he wrote his *Index* at leaſt 20 more have been diſcovered. They are very generally divided into three kinds: 1. The larger, which are as big as a moderate fowl, called *macaos* and *cocketoons*; theſe have very long tails. 2. The middle-ſized ones, commonly called *parrots*, which have ſhort tails, and are a little larger than a pigeon. And, 3. The ſmall ones, which are called *paroquets*, and have long tails, and are not larger than a lark or blackbird.

1. The pſittacus macao, or red and blue macao, is red, except the wing quills, which above are blue, below rufous: the ſcapular feathers are variegated with blue and green: the cheeks are naked and wrinkled. It is about two feet ſeven inches and a half long, and about as big as a capon. Edwards ſays, when perfect, it will meaſure a full yard from bill to tail. It inhabits Braſil, Guiana, and other parts of South America. It was formerly very common in St Domingo, but is now rarely found there. It generally lives in moiſt woods, eſpecially ſuch as are planted with a particular kind of palm, perhaps what is called the *macaw* tree. It does not in general learn to ſpeak, and its voice is particularly rough and diſagreeable. The fleſh is hard, black, and unſavoury, but makes good ſoup, and is much uſed by the inhabitants of Cayenne and other places. This ſpecies, in common with other parrots, is ſubject to fits when tamed; and though it will live for many years though the returns be pretty frequent, it generally falls a victim to that diſeaſe at laſt. The Americans call it *gonzalo*. 2. The pſittacus ararauna, or blue and yellow macaw, is blue above, and yellow below, and the cheeks are naked, with feathery lines. It is about the ſame ſize with the laſt, and inhabits Jamaica, Guiana, Braſil, and Surinam. 3. The pſitttacus ſeverus, or Braſilian green macaw, is black, with a greeniſh ſplendor; the bill and eyes are reddiſh, and the legs are yellow. It is about one foot and five inches long, and is common in Jamaica, Guiana, and Braſil. It is however comparatively rare; but it is extremely beautiful, and of a very amiable and ſociable temper when familiar and acquainted; but it can neither bear ſtrangers nor rivals: its voice is not ſtrong, nor does it articulate very diſtinctly the word *ara*. See Plate CCCCXVI.

4. The pſittacus aurora, or yellow amazon, is about 12 inches long, of a green colour, with blue wing quills, and a white front; its orbits are ſnowy. It inhabits Mexico or Braſil; but in all probability the latter, from the one which Salerne ſaw, and which pronounced Portugueſe words. The pſittacus guineenſis, or yellow lory, is about ten inches long, and is an inhabitant of Guinea. The bill is of a black colour; the cere, the throat, and ſpace about the eyes, are white; above the eye there is a patch of yellow, and the reſt of the head and neck is crimſon. The breaſt is yellow, wing coverts green, and the quills are blue, edged with yellow. Under the wings, belly, thighs, vent, and to the under part of the tail, the colour is white, which laſt is tipped with red; the legs are duſky, and the claws black. See Plate CCCCXVI.

5. The pſittacus pullarius, red-headed Guinea parraket, or Guinea ſparrow, is about five inches and a half long. It inhabits Guinea, and is found in Ethiopia, the Eaſt Indies, and the iſland of Java, and ſometimes in Surinam. It is green, with a red front, fulvous tail, black bar, and cinereous orbits. The male of this ſpecies is peculiarly affectionate to the female. See Plate CCCCXVI.

In Mr White's *Journal of a Voyage to New South Wales*, we find a deſcription, with excellent engravings, of ſeveral ſpecies of this extenſive genus; and in Governor Philip's Voyage to the ſame place, we find deſcriptions and prints of ſeveral of the ſame ſpecies. But the moſt particular of the later authors are Buffon and Latham, eſpecially the laſt; to whoſe extenſive and accurate work we therefore refer our readers for that information which our limits permit us not to give. See his *Synopſis*, vol. i. p. 194—323. See alſo *Buffon*, vol. vi. p. 63—245.

PSOAS, in anatomy. See there, *Table of the Muſcles*.

PSOPHIA, in ornithology; a genus belonging to the order *gallinæ*. The bill is moderate; the upper mandible is convex; the noſtrils are oblong, ſunk, and pervious; the tongue is cartilaginous, flat, and fringed at

Pſittacus ‖ Pſophia.

Pſophia, Pſoralea.

at the end; and the legs are naked a little above the knees. The toes are three before and one behind; the laſt of which is ſmall, with a round protuberance beneath it, which is at a little diſtance from the ground. Mr Latham only enumerates two ſpecies: 1. Pſophia crepitans, or gold-breaſted trumpeter. Its head and breaſt are ſmooth and ſhining green. By the Spaniards of Maynas it is called *trompetero*, and by the French at Cayenne *agami*, under which laſt Buffon deſcribes it. It inhabits various parts of South America, Braſil, Guiana, Surinam, &c. but it is moſt plenty in the Amazons country. It is about 20 inches long, being about the ſize of a large fowl, and lays eggs rather larger, of a blue green colour. It is met with in the Carribee iſlands, where it is called a *pheaſant*, and its fleſh is reckoned as good as that of a pheaſant. The moſt characteriſtic and remarkable property of theſe birds conſiſts in the wonderful noiſe they make either of themſelves, or when urged by the keepers of the *menagerie*. Some have ſuppoſed it to proceed from the *anus*, and ſome from the belly. It is now certain, however, that this noiſe proceeds from the lungs. See Buffon, vol. iv. p. 390, &c. Another very remarkable circumſtance is, that they follow people through the ſtreets, and out of town, and that too even perfect ſtrangers. It is difficult to get rid of them; for if you enter a houſe, they will wait your return, and again join you, though often after an interval of three hours. "I have ſometimes (ſays M. de la Borde) betaken myſelf to my heels; but they ran faſter, and always got before me; and when I ſtopped, they ſtopped alſo.—I know one (continues he) which invariably follows all the ſtrangers who enter his maſter's houſe, accompanies them into the garden, takes as many turns as they do, and attends them back again." 2. Pſophia undulata, or undulated trumpeter, is about the ſize of a gooſe. The upper part of the body is of a pale reddiſh brown colour, beautifully undulated with black. The head is adorned with a dependent creſt. On each ſide of the neck, beneath the ears, begins a liſt of black, widening as it deſcends, and meeting on the lower part before, where the feathers become greatly elongated, and hang looſely down. The under parts are generally white, the legs are of a duſky blue colour, like the bill. It is a native of Africa: Mr Latham's ſpecimen came from Tripoli.

Plate CCCCXVI

PSORALEA, in botany: A genus of the decandria order, belonging to the diadelphia claſs of plants; and in the natural method ranking under the 32d order, *Papilionaceæ*. The calyx is powdered, with callous points, and as long as the monoſpermous legumen. The moſt remarkable ſpecies are, 1. The primata, or pinnated pſoralea, riſes with a woody ſoft ſtem, branching five or ſix feet high, pinnated leaves of three or four pair of narrow lobes terminated by an odd one, and at the axillas cloſe-ſitting blue flowers with white keels. It is a native of Ethiopia. 2. The bituminoſa, or bituminous trifoliate pſoralea, riſes with a ſhrubby ſtalk, branching ſparingly about two or three feet high, with ternate or three-lobed leaves of a bituminous ſcent, and blue flowers in cloſe heads; it grows in Italy and in France. 3. The aculeata, or aculeated prickly pſoralea, riſes with a ſhrubby branching ſtem three or four feet high, with ternate leaves, having wedge-ſhaped lobes, terminating in a recurved ſharp point, and the branches terminated by roundiſh heads of blue flowers; it grows in Ethiopia. Theſe plants flower here every ſummer; the firſt ſort greateſt part of that ſeaſon, and the others in July and Auguſt; all of which are ſucceeded by ſeeds in autumn. Keep them in pots in order for removing into the green-houſe in winter. They are propagated by ſeeds, ſown in a hot-bed in the ſpring; and when the plants are two or three inches high, prick them in ſeparate ſmall pots, and gradually harden them to the open air, ſo as to bear it fully by the end of May or beginning of June. They may alſo be propagated by cuttings any time in ſummer, planted in pots, and plunged in a little heat, or covered cloſe with hand-glaſſes, ſhaded from the ſun, and watered.

Pſychotria, Pſylli.

PSYCHOTRIA, in botany: A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 47th order, *Stellatæ*. The calyx is quinquedentate, perſiſting, and crowning the fruit; the corolla is tubulated; the berry globoſe; with two hemiſpherical fulcated ſeeds.

The ſpecies are four, viz. 1. Aſpatica; 2. Serpens; 3. Herbacea; and, 4. Emetica. They are all natives of Jamaica. See IPECACUANHA.

PSYLLI, (Strabo, Ptolemy): a people in the ſouth of Cyrenaica, ſo called from king Pſyllus, (Agathargides, quoted by Pliny): almoſt all overwhelmed by ſand driven by a ſouth wind (Herodotus). They had ſomething in their bodies fatal to ſerpents, and their very ſmell proved a charm againſt them, according to Pliny, Lucan, &c.

Though we may juſtly look upon it as fabulous, that theſe people had any thing in their bodies different from others; it is, however, certain that there are in Egypt at this day ſome perſons who have a method of handling the moſt poiſonous ſerpents without any hurt. Of theſe Mr Haſſelquiſt gives the following account:

"They take the moſt poiſonous vipers with their bare hands, play with them, put them in their boſoms, and uſe a great many more tricks with them, as I have often ſeen. I have frequently ſeen them handle thoſe that were three or four feet long, and of the moſt horrid ſort. I inquired and examined whether they had cut out the vipers poiſonous teeth; but I have with my own eyes ſeen they do not. We may therefore conclude, that there are to this day Pſylli in Egypt; but what art they uſe is not eaſily known. Some people are very ſuperſtitious, and the generality believe this to be done by ſome ſupernatural art which they obtain from inviſible beings. I do not know whether their power is to be aſcribed to good or evil; but I am perſuaded that thoſe who undertake it uſe many ſuperſtitions.

"The art of faſcinating ſerpents is a ſecret amongſt the Egyptians. It is worthy the endeavours of all naturaliſts, and the attention of every traveller, to learn ſomething deciſive as to this affair. How ancient this art is among the Africans, may be concluded from the ancient Marii and Pſylli, who were from Africa, and daily ſhowed proofs of it at Rome. It is very remarkable that this ſhould be kept a ſecret for more than 2000 years, being known only to a few, when we have ſeen how many other ſecrets have within that time been revealed.

Pſylli. vealed. The circumſtances relating to the faſcination of ſerpents in Egypt, related to me, were principally, 1. That the art is only known to certain families, who propagate it to their offspring. 2. The perſon who knows how to faſcinate ſerpents, never meddles with other poiſonous animals, ſuch as ſcorpions, lizards, &c. There are different perſons who know how to faſcinate theſe animals; and they again never meddle with ſerpents. 3. Thoſe that faſcinate ſerpents, eat them both raw and boiled, and even make broth of them, which they eat very commonly amongſt them; but in particular, they eat ſuch a diſh when they go out to catch them. I have been told, that ſerpents fried or boiled are frequently eat by the Arabians both in Egypt and Arabia, though they know not how to faſcinate them, but catch them either alive or dead. 4. After they have eat their ſoup, they procure a bleſſing from their ſcheik (prieſt or lawyer), who uſes ſome ſuperſtitious ceremonies, and amongſt others, ſpits on them ſeveral times with certain geſtures. This manner of getting a bleſſing from the prieſt is pure ſuperſtition, and certainly cannot in the leaſt help to faſcinate ſerpents; but they believe, or will at leaſt perſuade others, that the power of faſcinating ſerpents depends upon this circumſtance."

Notwithſtanding this teſtimony of Haſſelquiſt, the ſtory of the incantation of ſerpents, though frequently alluded to in Scripture, has been generally treated as a fable. It is, however, affirmed as a certain truth, both by Mr Bruce and M. Savary. "There is no doubt (ſays the former of theſe travellers) of its reality. The Scriptures are full of it. All that have been in Egypt have ſeen as many different inſtances as they choſe. Some have doubted that it was a trick; and that the animals thus handled had been firſt trained, and then deprived of their power of hurting; and fond of the diſcovery, they have reſted themſelves upon it, without experiment, in the face of all antiquity. But I will not heſitate to aver, that I have ſeen at Cairo (and this may be ſeen daily without any trouble or expence), a man who came from the catacombs, where the pits of the mummy birds are kept, who has taken a ceraſtes with his naked hand from a number of others lying at the bottom of a tub, has put it upon his bare head, covered it with the common red cap he wears, then taken it out, put it in his breaſt, and tied it about his neck like a necklace; after which it has been applied to a hen, and bit it, which died in a few minutes; and, to complete the experiment, the man has taken it by the neck, and beginning at his tail, has ate it as one would do a carrot or ſtock of celery, without any ſeeming repugnance.

"We know from hiſtory, that where any country has been remarkably infeſted with ſerpents, there the people have been ſcreened by this ſecret.

"To leave ancient hiſtory, I can myſelf vouch, that all the black people in the kingdom of Sennaar, whether Funge or Nuba, are perfectly armed againſt the bite of either ſcorpion or viper. They take the ceraſtes in their hands at all times, put them in their boſoms, and throw them to one another as children do apples or balls, without having irritated them by this uſage ſo much as to bite. The Arabs have not this ſecret naturally, but from their infancy they acquire an exemption from the mortal conſequences attending the bite of theſe animals, by chewing a certain root, and waſhing themſelves (it is not anointing) with an infuſion of certain plants in water." Pſylli ‖ Ptelea.

From this account we ſhould be apt to think, that theſe vipers really *would not* bite any who were thus armed againſt their poiſon; eſpecially as he adds, that he "conſtantly obſerved, that the viper, however lively before, upon being ſeized by any of theſe barbarians, ſeemed as if taken with ſickneſs and feebleneſs, frequently ſhut his eyes, and never turned his mouth towards the arm of the perſon who held him." Yet in another place, ſpeaking of the activity of the ceraſtes, he ſays, "I ſaw one of them at Cairo, in the houſe of Julian and Roſa, crawl up the ſide of a box in which there were many, and there lie ſtill, as if hiding himſelf, till one of the people who brought them to us came near him; and though in a very diſadvantageous poſture, ſticking as it were perpendicularly to the ſide of the box, he leaped near the diſtance of three feet, and faſtened between the man's forefinger and thumb, ſo as to bring the blood. The fellow ſhowed no ſigns of either pain or fear, and even kept him with us full four hours, without his applying any ſort of remedy, or ſeeming inclined to do ſo."

It is difficult to ſee how theſe two accounts can be reconciled. If thoſe who catch vipers are in danger of being bit by them *after* they are catched, certainly they muſt be ſo before, and then the whole relation becomes contradictory. Our author tells us, that theſe feats were performed *for a ſeaſon*, by thoſe who were artificially armed againſt the viper's poiſon, as well as thoſe who had the exemption naturally; but though put in poſſeſſion of the drugs, he never had the courage to make the experiment. That he ſhould have made ſuch a dreadful experiment on *himſelf*, no perſon in his ſenſes would expect; but it is indeed very ſurpriſing, that he did not attempt by means of theſe medicines to arm ſome of the brute creatures, of the lives of which he was ſufficiently prodigal, againſt the effects of that deadly poiſon by which ſo many of them periſhed.—As ſurpriſing it is, that he did not try what effect the root or its decoction would have upon the ſerpents themſelves; or that though he ſays he had a ſmall quantity of this extraordinary root by him, he gave neither drawing nor deſcription of it.

Though it is impoſſible to reconcile the particulars of this account to one another, the general fact of the incantation is confirmed by the teſtimony of M. Savary. This writer tells us, that he ſaw at the feaſt of Sidi Ibrahim, a troop of people, ſeemingly poſſeſſed, with naked arms and a fierce look, holding in their hands enormous ſerpents, which twined round their body, and endeavoured to eſcape. Theſe Pſylli, graſping them ſtrongly by the neck, avoided the bite; and notwithſtanding their hiſſing, tore them with their teeth, and ate them alive, while the blood ſtreamed from their mouth.

PTARMIGAN, in ornithology. See TETRAO.

PTELEA, SHRUB-TREFOIL: A genus of the monogynia order, belonging to the tetrandria claſs of plants; and in the natural method ranking with thoſe of which the order is doubtful. The corolla is tetrapetalous; the calyx quadripartite inferior; the fruit is monoſpermous, with a roundiſh membrane in the middle.

Pteris.

The ſpecies are, 1. The trifoliata, or Carolina ſhrub-trefoil, hath a ſhrubby upright ſtem, dividing into a branchy head eight or ten feet high, covered with a ſmooth purpliſh bark, trifoliate leaves, formed of oval ſpear-ſhaped folioles, and the branches terminated by large bunches of greeniſh-white flowers, ſucceeded by roundiſh, bordered capſules. 2. The viſcoſa, or viſcous Indian ptelea, riſes with ſeveral ſtrong ſhrubby ſtems, branching erectly 12 or 15 feet high, having a light brown bark, ſpear-ſhaped, ſtiff, ſimple leaves, and the branches terminated by cluſters of greeniſh flowers.

The firſt ſpecies is a hardy deciduous ſhrub, and a proper plant for the ſhrubbery and other ornamental plantations to increaſe the variety. It is propagated by ſeeds, layers, and cuttings.

The ſecond ſpecies is a ſtove-plant, and is propagated commonly by ſeeds.

PTERIS, in botany; a genus of the order of filices, belonging to the cryptogamia claſs of plants. The fructifications are in lines under the margin. There are 19 ſpecies; the moſt remarkable is the aquilina, or common female fern. The root of this is viſcid, nauſeous, and bitteriſh; and like all the reſt of the fern tribe, has a ſalt, mucilaginous taſte. It creeps under the ground in ſome rich ſoils to the depth of five or ſix feet, and is very difficult to be deſtroyed. Frequent mowing in paſture-grounds, plentiful dunging in arable lands, but, above all, pouring urine upon it, are the moſt approved methods of killing it. It has, however, many good qualities to counterbalance the few bad ones. Fern cut while green, and left to rot upon the ground, is a good improver of land; for its aſhes, if burnt, will yield the double quantity of ſalt that moſt other vegetables will.—Fern is alſo an excellent manure for potatoes; for if buried beneath their roots, it never fails to produce a good crop.—Its aſtringency is ſo great, that it is uſed in many places abroad in dreſſing and preparing kid and chamois leather.—In ſeveral places in the north, the inhabitants mow it green, and, burning it to aſhes, make thoſe aſhes up into balls, with a little water, which they dry in the ſun, and make uſe of them to waſh their linen with inſtead of ſoap. In many of the Weſtern Iſles the people gain a very conſiderable profit from the ſale of the aſhes to ſoap and glaſs makers.—In Glen Elg in Inverneſsſhire, and other places, the people thatch their houſes with the ſtalks of this fern, and faſten them down with ropes made either of birk-bark or heath. Sometimes they uſe the whole plant for the ſame purpoſe, but that does not make ſo durable a covering.—Swine are fond of the roots, eſpecially if boiled in their waſh.—In ſome parts of Normandy we read that the poor have been reduced to the miſerable neceſſity of mixing them with their bread. And in Siberia, and ſome other northern countries, the inhabitants brew them in their ale, mixing one-third of the roots to two-thirds of malt.—The ancients uſed the root of this fern, and the whole plant, in decoctions and diet-drinks, in chronic diſorders of all kinds, ariſing from obſtructions of the viſcera and the ſpleen. Some of the moderns have given it a high character in the ſame intentions, but it is rarely uſed in the preſent practice. The country people, however, ſtill continue to retain ſome of its ancient uſes; for they give the powder of it to deſtroy worms, and look upon a bed of the green plant as a ſovereign cure for the rickets in children.

Pterocarpus
||
Ptinus.

PTEROCARPUS, in botany: A genus of the decandria order, belonging to the diadelphia claſs of plants; and in the natural method ranking under the 32d order, *Papilionaceæ*. The calyx is quinquedentate, the capſule falcated, filiaceous, varicoſe. The ſeeds are few and ſolitary. There are four ſpecies, viz. 1. *Draco*; 2. *Ecaſtaphyllum*; 3. *Lunatus*; and, 4. *Santalinus*. This laſt is by ſome referred to the genus *Santalum*. It is called *red ſaunders*; and the wood is brought from the Eaſt Indies in large billets, of a compact texture, a dull red, almoſt blackiſh colour on the outſide, and a deep brighter red within. This wood has no manifeſt ſmell, and little or no taſte. It has been commended as a mild aſtringent, and a corroborant of the nervous ſyſtem; but theſe are qualities that belong only to the yellow ſort.

The principal uſe of red ſaunders is as a colouring drug; with which intention it is employed in ſome formulæ, particularly in the *tinctura lavendulæ compoſita*. It communicates a deep red to rectified ſpirit, but gives no tinge to aqueous liquors; a ſmall quantity of the reſin, extracted by means of ſpirit, tinges a large one of freſh ſpirit of an elegant blood-red. There is ſcarcely any oil, that of lavender excepted, to which it communicates its colour. Geoffroy and others take notice, that the Brazil woods are ſometimes ſubſtituted for red ſaunders; and the college of Bruſſels are in doubt whether all that is ſold among them for ſaunders be not really a wood of that kind. According to the account which they have given, their ſaunders is certainly the Brazil wood; the diſtinguiſhing character of which is, that it imparts its colour to water.

PTEROCOCEUS, in botany, is a ſpecies of the genus Calligonum. See CALLIGONUM.

PTERONIA, in botany: A genus of the polygamia equalis order, belonging to the ſyngeneſia claſs of plants; and in the natural method ranking under the 49th order, *Compoſitæ*. The receptacle is full of multipartite briſtles; the pappus a little plumy; the calyx imbricated.

PTEROSPERMUM, in botany: A genus of the polyandria order, belonging to the monodelphia claſs of plants; and in the natural method ranking under the 37th order, *Columniferæ*. The calyx is quinquepartite; the corolla conſiſts of five oblong ſpreading petals. The filaments are about 15, which unite towards the baſe into a tube. The ſtyle is cylindrical; the capſule is oval, woody, and quinquelocular, each of which are bivalved, containing many oblong, compreſſed, and winged ſeeds. There is only one ſpecies, viz. the *Pentapetes*, a native of the Eaſt Indies; the wood of which is very hard, and very like that of the holly-tree.

PTINUS, a genus of inſects belonging to the order of coleoptera. The antennæ are filiform: The laſt or exterior articulations are longer than the others: The thorax is nearly round, without a margin, into which the head is drawn back or received: The feet are made for leaping. The moſt remarkable ſpecies are,

1. The pectinicornis. This is produced from a worm that lodges in wood and the trunks of trees, ſuch as the willow, where it makes deep round holes, turns to a winged inſect, takes flight, and rooſts upon flowers. It is diſtinguiſhed by its antennæ pectinated on one

ſide

Ptiſan || Ptolemy.

ſide, whence it has the name of *feathered*. The elytra and thorax are of a deep clay-coloured brown, the antennæ and legs are of a pale brown.

2. The pertinax. The form of this inſect reſembles the preceding one, ſaving that its antennæ are filiform. It is all over of a deep blackiſh brown colour reſembling ſoot. It attacks houſehold-furniture, clothes, furs, and eſpecially animals dried and preſerved in collections of natural hiſtory, where it makes great havock. When caught, this inſect bends its legs, draws back its head, and lies as if it was dead till it thinks itſelf out of danger. It cannot be forced out of this ſtate of inaction either by pricking or tearing: nothing but a ſtrong degree of heat can oblige it to reſume its motion and run away. There are many beautiful varieties of this genus; but they in general eſcape our attention by their minuteneſs, and living among hay, dried leaves, and divers other duſty matters, where they undergo their metamorphoſes. The larvæ of ſome are found in trunks of decayed trees, in old tables, chairs, &c. See Plate CCCCXVI.

PTISAN, is properly barley decorticated, or deprived of its hulls, by beating in a mortar, as was the ancient practice; though the cooling potion obtained by boiling ſuch barley in water, and afterwards ſweetening the liquor with liquorice-root, is what at preſent goes by the name of *ptiſan*; and to render it laxative, ſome add a little ſena or other ingredient of the ſame intention.

PTOLEMAIC *Syſtem of Aſtronomy*, is that invented by Claudius Ptolemæus. See PTOLEMY (Claudius).

PTOLEMAIS, (anc. geog.); the port of Arſinoë, ſituated on the weſt branch of the Nile, which concurs to form the iſland called *Nomos Heracleotes*, to the ſouth of the vertex of the Delta.

PTOLEMAIS, (Strabo); the largeſt and moſt conſiderable town of the Thebais, or Higher Egypt, and in nothing ſhort of Memphis; governed in the manner of a Greek republic; ſituated on the weſt ſide of the Nile, almoſt oppoſite to Coptos. This town, which was built by Ptolemy Philadelphus, is now known by the name of *Ptolometa*. The walls and gates are ſtill entire, and there are a vaſt number of Greek inſcriptions, but only a few columns of the portico remain. There is likewiſe an Ionic temple, done in the moſt ancient manner of executing that order, of which Mr Bruce took a drawing, which is preſerved in the king's collection.—Another, of Cyrenaica, anciently called *Barce*.—A third of the Troglodytica, ſurnamed *Epitheras*, from the chace of wild beaſts, as elephants: lying in the ſame parallel with Meroë (Strabo); on the Arabian gulf (Pliny); 4820 ſtadia to the ſouth of Berenice.—A fourth, of Galilee, anciently called *Aca*, or *Acon*; made a Roman colony under the emperor Claudius (Pliny).—A fifth of Pamphylia; ſituated near the river Melas, on the borders of Cilicia Aſpera.

PTOLEMY (Soter, or Lagus), king of Egypt, a renowned warrior, and an excellent prince: he eſtabliſhed an academy at Alexandria, and was himſelf a man of letters. Died 284 B. C. aged 92.

PTOLEMY (Philadelphus), his ſecond ſon, ſucceeded him to the excluſion of Ptolemy Ceraunus. He was renowned as a conqueror, but more revered for his great virtues and political abilities. He eſtabliſhed and augmented the famous Alexandrian library, which had been begun by his father. He greatly increaſed the commerce of Egypt, and granted conſiderable privileges to the Jews, from whom he obtained a copy of the Old Teſtament, which he cauſed to be tranſlated into Greek, and depoſited in his library. This is ſuppoſed to have been the verſion called the *Septuagint*. He died 246 years B. C. aged 64.

Ptolemy || Publius.

PTOLEMY (Ceraunus), the elder brother, fled to Seleucus king of Macedon, who received him hoſpitably; in return for which he aſſaſſinated him, and uſurped his crown. He then invited Arſinoë, who was his widow and his own ſiſter, to ſhare the government with him; but as ſoon as he got her in his power, he murdered her and her children. He was at length defeated, killed, and torn limb from limb by the Gauls, 279 B. C.

PTOLEMY (Claudius), a celebrated mathematician and aſtrologer, was born at Peluſium, and ſurnamed by the Greeks *Moſt Divine* and *Moſt Wiſe*. He flouriſhed at Alexandria in the ſecond century, under the reigns of Adrian and Marcus Aurelius, about the 138th year before the Chriſtian era. There are ſtill extant his Geography, and ſeveral learned works on aſtronomy. The principal of which are, 1. The Almageſt; 2. *De Judiciis Aſtrologicis*; 3. *Planiſphærium*. His ſyſtem of the world was for many years adopted by the philoſophers and aſtronomers; but the learned have rejected it for the ſyſtem of Copernicus. See ASTRONOMY, n° 16.

PTYALISM, in medicine, a ſalivation, or frequent and copious diſcharge of ſaliva. The word is Greek, formed from πτυω "to ſpit."

PUBERTY, denotes the age at which a perſon is capable of procreating or begetting children. See MAN, n° 13—18.

PUBERTY, in law, is fixed at the age of 12 in females, and 14 in males; after which they are reckoned to be fit for marriage. But as to crimes and puniſhments, the age of puberty is fixed at 14 in both ſexes.

PUBES, in anatomy, denotes the middle part of the hypogaſtric region in men or women, lying between the two inguina or groins.

Section of the PUBES. See MIDWIFERY and *SIGAULTIAN Operation*.

PUBES, in botany, the hair or down on the leaves of ſome plants. See HAIR.

PUBLICAN, among the Romans, one who farmed the taxes and public revenues.

PUBLICATION, the art of making a thing known to the world, the ſame with promulgation.

PUBLIUS SYRUS, a Syrian mimic poet, who flouriſhed about 44 years before Chriſt. He was originally a ſlave ſold to a Roman patrician, called *Domitius*, who brought him up with great attention, and gave him his freedom when of age. He gained the eſteem of the moſt powerful men at Rome, and reckoned J. Cæſar among his patrons. He ſoon eclipſed the poet Laberius, whoſe burleſque compoſitions were in general eſteem. There remains of Publius, a collection of moral ſentences, written in iambics, and placed in alphabetical order.

Puceron || Puffendorf.

OAK PUCERON, a name given by naturaliſts to a very remarkable ſpecies of animal of the puceron kind. They bury themſelves in the clefts of the oak and ſome other trees, and getting into the crevices, where the bark is a little ſeparated from the wood, they there live at eaſe, and feed to their fill, without being expoſed to their common enemies. They are larger than the other pucerons, the winged ones being nearly as large as a common houſe fly; and thoſe without wings are alſo larger than any other ſpecies of the ſame genus. The winged ones are black, and the others of a coffee colour. Their trunk is twice the length of their bodies, and, when walking, it is carried ſtraight along the belly, trailing behind it with the point up. When the creature has a mind to ſuck a part of the tree that is juſt before it, it draws up, and ſhortens the trunk, till it brings it to a proper length and direction; but when it ſucks in the common way, it crawls upon the inner ſurface of the bark, and the turned up end of the trunk, which reſembles a tail, fixes itſelf againſt the wood that is behind it, or contiguous to its back, and ſucks there. The extremity of this trunk holds ſo faſt by the wood, that when it is pulled away, it frequently brings a ſmall piece of the wood away with it.

The ants are as fond of theſe as of the other ſpecies of pucerons, and that for the ſame reaſon, not feeding upon them, but on their dung, which is a liquid matter of a ſweet taſte, and is the natural juice of the tree, very little altered. Theſe creatures are the ſureſt guides where to find this ſpecies of puceron; for if we at any time ſee a number of theſe crawling up an oak to a certain part, and there creeping into the clefts of the bark, we may be aſſured that in that place there are quantities of theſe oak pucerons. The ants are ſo extremely fond of the juices of the tree, when prepared for them by paſſing through the body of this animal, that when the puceron has a drop not yet evacuated, but hanging only in part out at the paſſage, an ant will often ſeize on it there.

PUCERONS, *Vine-fretters*, or *Plant-lice*. See APHIS.

PUDENDA, the parts of generation in both ſexes. See ANATOMY, n° 107 and 108.

PUERILITY, in diſcourſe, is defined by Longinus to be a thought which, by being too far fetched, becomes flat and inſipid. Puerility, he adds, is the common fault of thoſe who affect to ſay nothing but what is brilliant and extraordinary.

PUFFENDORF (Samuel de) was born in 1631 at Fleh, a little village in Miſnia, a province in Upper Saxony; and was ſon of Elias Puffendorf, miniſter of that place. After having made great progreſs in the ſciences at Leipſic, he turned his thoughts to the ſtudy of the public law, which in Germany conſiſts of the knowledge of the rights of the empire over the princes and ſtates of which it is compoſed, and thoſe of the princes and ſtates with reſpect to each other. But though he uſed his utmoſt efforts to diſtinguiſh himſelf, he deſpiſed thoſe pompous titles which are ſo much ſought for at univerſities, and never would take the degree of doctor. He accepted the place of governor to the ſon of Mr Coyet, a Swediſh nobleman, who was then ambaſſador from Sweden to the court of Denmark. For this purpoſe he went to Copenhagen, but continued not long at eaſe there; for the war being renewed ſome time after between Denmark and Sweden, he was ſeized with the whole family of the ambaſſador. During his confinement, which laſted eight months, as he had no books, and was allowed to ſee no perſon, he amuſed himſelf by meditating on what he read in Grotius's treatiſe *De Jure Belli et Pacis*, and the political writings of Mr Hobbes. Out of theſe he drew up a ſhort ſyſtem, to which he added ſome thoughts of his own, and publiſhed it at the Hague in 1660, under the title of *Elementa Juriſprudentiæ Univerſalis*. This recommended him to the elector Palatine, who invited him to the univerſity of Heidelberg, where he founded in his favour a profeſſorſhip of the law of nature and nations, which was the firſt of that kind eſtabliſhed in Germany. Puffendorf remained at Heidelberg till 1673, when Charles XI. of Sweden gave him an invitation to be profeſſor of the law of nature and nations at Lunden; which place the elector Palatine reluctantly allowed him to accept. He went thither the ſame year; and after that time his reputation greatly increaſed. Some years after, the king of Sweden ſent for him to Stockholm, and made him his hiſtoriographer, and one of his counſellors. In 1688, the elector of Brandenburg obtained the conſent of his Swediſh majeſty, that he ſhould come to Berlin, in order to write the hiſtory of the elector William the Great; and in 1694 made him a baron. But he died that ſame year of an inflammation in his feet, occaſioned by cutting his nails; having attained his grand climacteric. Of his works, which are numerous, the following are the principal: 1. A Treatiſe on the Law of Nature and Nations, written in German; of which there is an Engliſh tranſlation with Barbeyrac's Notes. 2. An Introduction to the Hiſtory of the Principal States which at preſent ſubſiſt in Europe; written in German; which has been alſo tranſlated into Engliſh. 3. The Hiſtory of Sweden, from Guſtavus Adolphus's expedition into Germany to the abdication of Queen Chriſtina. 4. The Hiſtory of Charles Guſtavus, two volumes folio, &c.

Puffendorf || Pulex.

PUFFIN. See ALCA, n° 3.

PUGET (Peter Paul), one of the greateſt painters and ſculptors France ever produced, though but little noticed by their own writers, was born at Marſeilles in 1623. In his youth he was the diſciple of Roman, an able ſculptor; and then went to Italy, where he ſtudied painting and architecture. In painting he ſo well imitated the manner of Peter de Cortona, that this painter deſired to ſee him, and entered into a friendſhip with him. In 1657, a dangerous diſorder obliged him to renounce the pencil, and devote himſelf to ſculpture; and his reputation cauſing him to be invited to Paris, he enjoyed a penſion of 1200 crowns, as ſculptor and director of the works relating to veſſels and galleys. He died at Marſeilles in 1695, and has left a number of admirable ſtatues behind him both in France and Italy.

PUGIL, in phyſic, &c. ſuch a quantity of flowers, ſeeds, or the like, as may be taken up between the thumb and two fore-fingers. It is reckoned the eighth part of the manipulus or handful.

PULEGIUM, or *Penny-Royal*. See MENTHA.

PULEX, the FLEA, in zoology, a genus of inſects belonging to the order of aptera. It has two eyes,

Pulex. and ſix feet fitted for leaping; the feelers are like threads; the roſtrum is inflected, ſetaceous, and armed with a ſting; and the belly is compreſſed.

The generation of this familiar vermin affords ſomething very curious, firſt diſcovered by Sig. Diaciento Ceſtore. Fleas bring forth eggs, or nits, which they depoſit on animals that afford them a proper food: theſe eggs being very round and ſmooth, uſually ſlip ſtraight down; unleſs detained by the piles, or other inequalities, of the clothes, hairs, &c. Of theſe eggs are hatched white worms, of a ſhining pearl colour, which feed on the ſcurfy ſubſtance of the cuticle, the downy matter gathered in the piles of clothes, or other the like ſubſtances. In a fortnight they come to a tolerable ſize, and are very lively and active; and, if at any time diſturbed, they ſuddenly roll themſelves into a kind of ball. Soon after this, they come to creep, after the manner of ſilk-worms, with a very ſwift motion. When arrived at their ſize, they hide themſelves as much as poſſible, and ſpin a ſilken thread out of their mouth, wherewith they form themſelves a ſmall round bag, or caſe, white within as paper, but without always dirty, and fouled with duſt. Here, after a fortnight's reſt, the animalcule burſts out, transformed into a perfect flea; leaving its exuviæ in the bag. While it remains in the bag, it is milk-white, till the ſecond day before its eruption; when it becomes coloured, grows hard, and gets ſtrength; ſo that upon its firſt delivery it ſprings nimbly away.

The flea, when examined by the microſcope, affords a very pleaſing object. It is covered all over with black, hard, and ſhelly ſcales or plates, which are curiouſly jointed, and folded over one another in ſuch a manner as to comply with all the nimble motions of the creature. Theſe ſcales are all curiouſly poliſhed, and are beſet about the edges with ſhort ſpikes in a very beautiful and regular order. Its neck is finely arched, and much reſembles the tail of a lobſter: the head alſo is very extraordinary; for from the ſnout-part of it there proceed the two fore-legs, and between theſe is placed the piercer or ſucker with which it penetrates the ſkin to get its food. Its eyes are very large and beautiful, and it has two ſhort horns or feelers. It has four other legs joined all at the breaſt. Theſe, when it leaps, fold ſhort one within another; and then, exerting their ſpring all at the ſame inſtant, they carry the creature to a ſurpriſing diſtance. The legs have ſeveral joints, and are very hairy, and terminate in two long and hooked ſharp claws. The piercer or ſucker of the flea is lodged between its fore-legs, and includes a couple of darts or lancets; which, after the piercer has made an entrance, are thruſt farther into the fleſh, to make the blood flow from the adjacent parts, and occaſion that round red ſpot, with a hole in the centre of it, vulgarly called a *flea-bite*. This piercer, its ſheath opening ſidewiſe and the two lancets within it, are very difficult to be ſeen; unleſs the two fore-legs, between which they are hid, be cut off cloſe to the head: for the flea rarely puts out its piercer, except at the time of feeding, but keeps it folded inwards; and the beſt way of ſeeing it is by cutting off firſt the head, and then the fore-legs, and then it is uſually ſeen thruſt out in convulſions.

By keeping fleas in a glaſs tube corked up at both ends, but ſo as to admit freſh air, their ſeveral actions may be obſerved, and particularly their way of coupling, which is performed tail to tail; the female, which is much the larger, ſtanding on the male. They may alſo be thus ſeen to lay their eggs, not all at once, but ten or twelve in a day, for ſeveral days ſucceſſively; which eggs will be afterwards found to hatch ſucceſſively in the ſame order. The flea may eaſily be diſſected in a drop of water; and by this means the ſtomach and bowels, with their periſtaltic motion, may be diſcovered very plainly, as alſo their teſtes and penis, with the veins and arteries, though minute beyond all conception. Mr Lieuwenhoek affirms alſo, that he has ſeen innumerable animalculés, ſhaped like ſerpents, in the ſemen maſculinum of a flea. This blood-thirſty inſect, which fattens at the expence of the human ſpecies, prefers the more delicate ſkin of women; but preys neither upon epileptic perſons, nor upon the dead or dying. It loves to neſtle in the fur of dogs, cats, and rats. The neſts of river-ſwallows are ſometimes plentifully ſtored with them. Pulex. *Barbut's Genera of Inſects*, p. 330, &

Fleas are apterous; walk but little, but leap to a height equal to 200 times that of their own body. This amazing motion is performed by means of the elaſticity of their feet, the articulations of which are ſo many ſprings. Thus it eludes, with ſurpriſing agility, the purſuit of the perſon on whom it riots.—Among the memorabilia of fleas, one, they ſay, has been ſeen to draw a ſmall ſilver piece of ordnance to which it was faſtened, the firing of the gun nowiſe daunting its intrepidity. The owner carried it about in a litttle box lined with velvet, every now and then placing it on her arm to let it feed; but winter put an end to the being of this martial flea. Another flea that became ſlave to an Engliſhman, had, for its daily and eaſy taſk, to drag its golden chain and padlock, of the weight of one grain. A third flea ſerved as a thrill-horſe to an Engliſh artiſt, who had made an ivory coach and ſix, that carried a coachman with his dog between his legs, a poſtilion, two footmen, and four inſide riders. At Surat fleas, bugs, and other voracious vermin, are in ſo great veneration, that they have an hoſpital endowed, where every night a poor fellow, for hire, ſuffers himſelf to be preyed upon. He is faſtened naked on a bed, when the feaſt begins at his expence. In Turkey there is a ſimilar foundation for decayed dogs; an inſtitution leſs ridiculous than the other. Mercurial ointment, brimſtone, a fumigation with the leaves of penny-royal, or freſh-gathered leaves of that plant ſewed up in a bag, and laid in the bed, are remedies pointed out as deſtructive of fleas.

Pulex-Arboreus, in natural hiſtory, the name given by Mr Reaumur to a very large genus of ſmall animals. They are a kind of half-winged creatures: they have granulated antennæ; and ſome of them, in their moſt perfect ſtate, have complete wings. Theſe are diſtinguiſhed from the others by the name of *muſca-pulex* or the *winged-pulex*.

The ſeveral ſpecies of theſe creatures are of different colours: ſome are brown, others yellow; but the moſt frequent are green. They all feed upon the leaves of trees, which become withered and curled up on their eroding them; and they are ſo common, that wherever a leaf of a tree is found curled up, or of a different form from the others, it is highly probable theſe

Pulex. animals are on it, or that it is their work. Among trees the willow and the roſe are the moſt infected by them; and among plants, the bean and the poppy. They live a ſocial life, multitudes of males and females being found together. The females are eaſily diſtinguiſhed from the males, by their being thicker in the body, and having larger bellies.

It is very wonderful, that of all the known animals of the winged kind, theſe are the only ones which are viviparous. This is eaſily ſeen beyond a poſſibility of doubt; for, on examining a cluſter of them together, it is a common thing to ſee, by the help of a ſmall magnifier, a female in the act of parturition; and the author* of this account frequently ſaw the young pulex protruded out, from a paſſage near the anus of the female, perfectly formed. He had ſuſpected this from the total want of eggs among ſo numerous a tribe of animals, and from their remarkably ſpeedy propagation, and was thus convinced of it by ocular demonſtration.

* *Reaumur, Hiſtory of Inſects.*

They are armed with a tender and flexile proboſcis; with which they ſeize hold of the young ſhoots of the tree they live upon, twiſting the proboſcis round it. Theſe creatures are always ſeen naked and expoſed, ſtanding on the outſide of the ſtalks and leaves, and ſucking in their juices for nouriſhment with their proboſcis. But there is another ſpecies of them, which are alike viviparous, and agree with them in all reſpects except in their manner of living. Theſe get into the inner ſubſtance of the leaves, like the worms called *aſcarides;* and feed on the parenchyma, being defended from all injuries by living between the integuments. In this caſe, the leaves they bury themſelves in become ſcabrous and deformed, and produce a ſort of galls: ſo that Malpighi erred in ſuppoſing all the galls of trees to be produced by the animals hatched of the eggs of ichneumon flies; ſince theſe animals, which are viviparous, and are of a very different kind from the worms of the ichneumon flies, equally produce them. A female of the ſpecies here treated of has been ſeen to bring forth ſeven young ones in a day: and thus from reſiding alone in the tubercles which ſhe had formed on a leaf, ſhe in a little time becomes the mother of a numerous family; each of which raiſes its own tumour or gall on the leaf, which at firſt are ſmall and round, and of a beautiful red like kermes.

Such of theſe as are of the male ſpecies have a certain time of reſt, in which they lie buried in a ſilky matter, and afterwards become winged, flying nimbly about; whereas the females never are able to fly, but remain always half-winged. It is to be obſerved, however, that there is a different ſpecies of winged inſects frequently found flying about the female pulices, as well as their own males; ſo that all the ſmall-winged inſects about them are not to be thought of their own ſpecies. Theſe do not greatly differ in figure; but the one are harmleſs, and the others have ſtings, and hurt any part of the body on which they fix.

Pulex Aquaticus auctorum (monoculus pulex of Linnæus), in entymology, is a ſpecies of the genus Monoculus, which ſee. It is a moſt curious inſect of the ſize of a flea, and has been noticed by many writers who have examined its parts with accuracy, and is that which, uniting together in vaſt numbers, occaſions the beautiful red patches which may be obſerved in a dry ſummer ſeaſon on ſtagnant waters, giving riſe to reports of water being turned to blood, and in the minds of the leſs informed thought to portend dire events. The other ſpecies of the ſame genus collect on waters in a ſimilar way, and occaſion a ſimilar appearance, as has been mentioned under the generic name, to which we refer our readers. See alſo Swammerdam's *Book of Nature*, p. 39.; Baker's *Employment for the Microſcope*, p. 302.; Schœffer's *Icon. Inſ.*; Sultz. *Inſ.* p. 30; De Seer's *Inſ.* vol. 7. &c. where there are alſo excellent figures of it. We have given a figure of it magnified and drawn from life: The outward form of the body, Swammerdam ſays, is a kind of ſquare; under the eye there is a ſharp beak; on the breaſt are a kind of arms divided into branches like the boughs of trees, and in the abdomen there is a tranſparent ſubſtance with the legs and tail, and in the hinder part of the body, its legs appear placed as it were on the middle of the back: The eyes are almoſt cloſe together, and are reticulated; the beak is tranſparent. Pulex. Plate CCCCXVI.

It appears that inſects of this tribe are enabled to bear the extremes of heat and cold: for Ray, in his *Hiſtoria Inſectorum*, p. 41. obſerves, that the *pulex fluviatilis* was met with by Mr Willoughby in a hot bath near Vicenza in Italy, the temperature of which was ſuch as to prevent any other living therein; and, on the contrary, O. Fabricius, in his *Fauna Grœnlandiæ*, p. 264. mentions the circumſtance of the *monoculus pulex* being frequently found under the ice in the ſtagnant waters of Greenland.

The chego, or *pulex minimus, cutem penetrans, Americanus* of Cateſby, is a very ſmall animal found in warm climates. It is a very troubleſome inſect, eſpecially to negroes and ſuch as are ſlovenly or go barefooted. They penetrate the ſkin, under which they lay a bunch of eggs, which ſwell to the bigneſs of a ſmall pea or tare. They are exceedingly painful; and unleſs great care is uſed in taking them out, they are dangerous. It is about one-fourth the ſize of a common flea; the figure is conſiderably magnified. From the mouth iſſues a hollow tube like that of a common flea, between a pair of antennæ. It has ſix jointed legs, and ſomething like a tail. Under it is one of its eggs, which is ſcarcely viſible to the naked eye. Theſe animals are a great nuiſance to moſt parts of America between the tropics. See Sir Hans Sloane's *Hiſtory of Jamaica*, Introd. p. cxxiv. and vol. ii. p. 191, 192. Plate CCCCXVI.

Pulex-Eaters, a name given by naturaliſts to a ſort of worms frequently found on the leaves of trees, where they devour the animals called *pulices arborei.*

Of theſe there are ſeveral ſpecies, which owe their origin to the eggs of different creatures; for there are none of them in their ultimate ſtate in this their time of feeding. According to the different animals whoſe eggs they are hatched from, theſe are of different form and ſtructure. Some are hexapodes, or endued with ſix feet; theſe belong to the beetle-tribe, and finally change into beetles like the parent animal from whoſe eggs they ſprung. Others have no legs, and are produced from the eggs of flies of various kinds. And, finally, others are genuine caterpillars, though ſmall; but theſe are the moſt rare of all.

The two general kinds are the hexapodes, or beetle-worms;

Pulley || Pulſe.

worms; and the apodes, or fly-worms. The fly which gives origin to the laſt of theſe is a four-winged one; and takes care always to depoſit her eggs in a place where there are plenty of the pulices, uſually on the ſtalk or young branches of a tree in the midſt of large families of them. The worm, as ſoon as hatched, finds itſelf in the midſt of abundance of food, preying at pleaſure on theſe animals, which are wholly defenceleſs. The ſtalks of the elder and woodbine are frequently found covered over with theſe pulices; and among them there may uſually be found one or more of theſe deſtroyers feeding at will, ſucking in the juices from their bodies, and then throwing away the dry ſkins. Beſides the worms of this four-winged fly, there is one of a two-winged waſp-fly, very deſtructive of theſe animals.

PULLEY, in mechanics, one of the five mechanical powers. See MECHANICS, p. 739.

PULMO, the LUNGS, in ANATOMY. See there, n° 117.

PULMONARIA, LUNGWORT: A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 41ſt order, *Aſperifoliæ*. The corolla is funnel-ſhaped, with its throat pervious; the calyx is priſmatic and pentagonal. There are ſeveral ſpecies; of which the moſt remarkable is the officinalis, common ſpotted lungwort, or Jeruſalem cowſlip. This is a native of woods and ſhady places in Italy and Germany, but has been cultivated in Britain for medicinal uſe. The leaves are of a green colour, ſpotted with white; and of a mucilaginous taſte, without any ſmell. They are recommended in phthiſis, ulcers of the lungs, &c. but their virtues in theſe diſeaſes are not warranted by experience.

PULO PINANG. See *PRINCE of Wales's Iſland*.

PULP, in pharmacy, the fleſhy and ſucculent parts of fruits extracted by infuſion or boiling, and paſſed through a ſieve.

PULPIT, an elevated place in a church, whence ſermons are delivered. The French give the ſame name to a reading-deſk.

PULPITUM, in the Grecian and Roman theatres, was a place where the players performed their parts. It was lower than the ſcena, and higher than the orcheſtra. It nearly anſwered to what we call the ſtage, as diſtinguiſhed from the pit and galleries.—*Pulpitum* was alſo a moveable deſk or pulpit, from which diſputants pronounced their diſſertations, and authors recited their works.

PULSE, in the animal economy, denotes the beating or throbbing of the heart and arteries.

No doctrine has been involved in more difficulties than that of pulſes; ſince, in giving a phyſiological account of them, phyſicians have eſpouſed quite oppoſite ſentiments; whilſt ſome doubt whether the pulſe is owing to the ſyſtole or diaſtole; as alſo, whether the motion of the heart and arteries is one and the ſame, for a moment of time.

With regard to motion, the pulſes are reckoned only four; great and little, quick and ſlow. When quickneſs and greatneſs are joined together, it becomes violent; and when it is little and ſlow it is called a *weak pulſe*. They are alſo ſaid to be *frequent* and *rare*, *equal* and *unequal*; but theſe are not the eſſential affections of motion. Frequency and quickneſs are often confounded with each other. A pulſe is ſaid to be *hard* or *ſoft*, with regard to the artery, according as it is tenſe, renitent, and hard, or flaccid, ſoft, and lax: for the diſpoſition of the arteries contributes greatly to the change of the pulſe; wherefore it ſometimes happens, that the pulſe in both arms is not alike, which is very common in a hemiplexy. Add to theſe a convulſive pulſe, which does not proceed from the blood, but from the ſtate of the artery; and is known by a tremulous ſubſultory motion, and the artery ſeems to be drawn upwards: this, in acute fevers, is the ſign of death; and is ſaid to be the pulſe in dying perſons, which is likewiſe generally unequal and intermitting. A *great* pulſe ſhows a more copious afflux of the blood to the heart, and from thence into the arteries; a *little* pulſe the contrary. Pulſe.

The pulſes of perſons differ according to the largeneſs of the heart and veſſels, the quantity and temperies of the blood, the elaſtic force of the canals; as alſo with regard to the ſex, age, ſeaſon, air, motion, food, ſleep, watchings, and paſſions of the mind. The pulſe is larger and more quick in men than in women; in the bilious and ſanguineo-bilious, than in the phlegmatic and melancholic. Thoſe who are lean, with tenſe fibres and large veſſels, have a greater and a ſtronger pulſe, than thoſe that are obeſe, with lax fibres and ſmall veſſels; whence they are more healthy, robuſt, and apt for labour. In children, the pulſe is quick and ſoft; in adults greater and more violent. In the old, it is commonly great, hard, and ſlow. Labour, motion, and exerciſe of the body, increaſe the circulation of the blood, the excretions, and particularly reſpiration; reſt renders the circulation ſlow and weak; intenſe ſpeaking increaſes the circulation, and conſequently renders the pulſe large and quick. In watching, the pulſe is more evident; in ſleep, more ſlow and languid. After drinking hot things, ſuch as coffee and tea, or hot bath-waters, as well as after meals, the pulſe vibrates more quick. But nothing produces a greater change in the pulſe than affections of the mind: in terror, it is unequal, ſmall, and contracted; in joy, frequent and great; in anger, quick and hard; in ſadneſs, ſlow, ſmall, deep, and weak; and in intenſe ſtudy, languid and weak. With regard to the air, when, after the predominancy of a weſt or ſouth wind, it becomes north or eaſt, the pulſe is ſtronger and larger; as alſo when the quickſilver riſes in the barometer. But when the atmoſphere is denſe, humid, rainy, with a long ſouth wind; as alſo where the life is ſedentary, the ſleep long, and the ſeaſon autumnal, the pulſe is languid and ſmall, and the perſpiration decreaſed. In May it is great, and ſometimes violent; in the middle of ſummer, quick but weak; in the autumn, ſlow, ſoft, and weak; in the winter, hard and great. A draſtic purge and an emetic render the pulſe hard, quick, and weak, with loſs of ſtrength; chalybeates, and the bark, render it great and robuſt, and the complexion lively; volatiles amplify and increaſe the pulſe; acids and nitrous remedies refrigerate the body, and appeaſe the pulſe; opiates and the like render it ſmall and weak, and decreaſe the elaſticity of the ſolids; and poiſons render it ſmall, contracted, and hard. When the quantity of the blood is too great, bleeding raiſes the pulſe.

PULSE, is alſo uſed for the ſtroke with which any medium

Pulteney. Pulverization.

medium is affected by the motion of light, ſound, &c. through it.

Sir Iſaac Newton demonſtrates, that the velocities of the pulſes in an elaſtic fluid medium (whoſe elaſticity is proportionable to its denſity) are in a ratio compounded of half the ratio of the elaſtic force directly, and half the ratio of the denſity inverſely; ſo that in a medium whoſe elaſticity is equal to its denſity, all pulſes will be equally ſwift.

PULSE, in botany, a term applied to all thoſe grains or ſeeds which are gathered with the hand; in contradiſtinction to corn, &c. which are reaped, or mowed: or, It is the ſeed of the leguminous kind of plants, as beans, vetches, &c. but is by ſome uſed for artichokes, aſparagus, &c.

PULTENEY (William), the famous oppoſer of Sir Robert Walpole in parliament, and afterward earl of Bath, was deſcended from one of the moſt ancient families in the kingdom, and was born in 1682. Being well qualified in fortune, he early procured a ſeat in the houſe of commons, and diſtinguiſhed himſelf as a warm partiſan againſt Queen Anne's miniſtry; whoſe errors he had ſagacity to detect, and ſpirited eloquence to expoſe. When King George I. came to the throne, Mr Pulteney was made ſecretary at war, and ſoon after cofferer to the king's houſehold; but the good underſtanding between this gentleman and Sir Robert Walpole, who then acted as prime miniſter, was interrupted in 1725, on a ſuſpicion that Walpole was deſirous of extending the limits of prerogative, and of promoting the intereſts of Hanover, to the prejudice of thoſe of Britain. His oppoſition to Sir Robert was indeed carried to ſuch indiſcriminate lengths, that ſome have been of opinion he often acted againſt meaſures beneficial to the public, merely from perſonal motives. It would be impracticable here to trace his parliamentary conduct: ſo it muſt ſuffice to obſerve in general, that he became ſo obnoxious to the crown, that in 1731 the king called for the council-book, and with his own hand ſtruck out his name from the liſt of privy-counſellors; a proceeding that only ſerved to inflame his reſentment and increaſe his popularity. Thus he ſtill continued to attack the miniſter with a ſeverity of eloquence and ſarcaſm that worſted every antagoniſt; ſo that Sir Robert was heard to declare, he dreaded that man's tongue more than another man's ſword. At length, when Walpole found the place of prime miniſter no longer tenable, and reſigned in 1741, among other promotions Mr Pulteney reſumed his place in the privy-council, and was created earl of Bath; a title purchaſed at the expence of that popularity which afterward he naturally enough affected to contemn. In 1760, toward the cloſe of the war, he publiſhed *A Letter to two Great Men*, recommending proper articles to be inſiſted on in a treaty of peace; which, though the writer was then unknown, was greatly applauded, and went through ſeveral impreſſions. He died in 1764; and as his only ſon died before him, the title became extinct.

PULVERIZATION, the art of pulverizing, or reducing a dry body into a fine powder; which is performed in friable bodies by pounding or beating them in a mortar, &c.; but to pulverize malleable ones, other methods muſt be taken. To pulverize lead, or tin, the method is this: Rub a round wooden box all over the inſide with chalk; pour a little of the melted metal nimbly into the box; when ſhutting the lid, and ſhaking the box briſkly, the metal will be reduced to powder.

Pumex ‖ Pump.

PUMEX, the PUMICE-STONE, a ſubſtance frequently thrown out of volcanoes, though there are many which are never known to throw it out. It is very full of pores and bliſters; in conſequence of which it is ſpecifically very light, and reſembles the frothy ſlag produced in our iron furnaces. It is of two colours, black and white; the former being that which it has when thrown out of the volcano; the latter, as Cronſtedt conjectures, being perhaps faded and bleached. M. Magellan conſiders it rather as a volcanic ejection than a volcanic production; and deſcribes it as of a white, reddiſh-brown, grey, or black colour. It is of a rough and porous conſiſtence, being made up of ſlender fibres parallel to each other, and very light, ſo that it ſwims on water. It ſtrikes fire with ſteel, though with difficulty, and ſeems originally to have been an aſbeſtos decompoſed by the action of fire; but, on obſerving the appearance of that glaſſy ſlag produced in the iron-furnaces, which entirely reſembles the pumice-ſtone, and is produced from the calcareous fluxes uſed to promote the fuſion of the ore, our author is of opinion that the formation of pumice may be rather attributed to that kind of froth which muſt be formed at the top of the melted matters in the volcanic crater. An hundred parts, according to Bergman, contain from 6 to 15 of magneſia, with a ſmall proportion of calcareous earth, and the greateſt part ſilex. Another kind of pumice, which ſeems to be a ferruginous granite altered by fire, has been diſcovered by Dolomieu at Stromboli.

Pumice-ſtone is uſed in ſome mechanical arts; as for rubbing and ſmoothing the ſurface of metals, wood, paſteboard, and ſtone; for which it is well fitted by reaſon of its harſh and brittle texture; thus ſcouring and carrying off the little inequalities from the ſurfaces juſt mentioned,

PUMICE-STONE. See the preceding article.

PUMP, an hydraulic machine for raiſing water by means of the preſſure of the atmoſphere.

Of the invention of pumps.

It would be an entertaining and not an uninſtructive piece of information to learn the progreſſive ſteps by which the ingenuity of man has invented the various methods of raiſing water. A pump muſt be conſidered as the laſt ſtep of this progreſs. Common as it is, and overlooked even by the curious, it is a very abſtruſe and refined invention. Nothing like it has been found in any of the rude nations whom the reſtleſs ſpirit of the Europeans has diſcovered, either in the new continent of America or the iſlands of the Pacific Ocean. Nay, it was unknown in the cultivated empire of China at the time of our arrival there by ſea; and it is ſtill a rarity everywhere in Aſia, in places unfrequented by the Europeans. It does not appear to have been known to the Greeks and Romans in early times; and perhaps it came from Alexandria, where phyſical and mathematical ſcience was much cultivated by the Greek ſchool under the protection of the Ptolemies. The performances of Cteſibius and Hero are ſpoken of by Pliny and Vitruvius as curious novelties.

Pump. ties (A). It is perhaps not difficult to trace the ſteps by which thoſe mechanicians were led to the invention. The Egyptian wheel was a common machine all over Aſia, and is ſtill in uſe in the remoteſt corners, and was brought by the Saracens into Spain, where it is ſtill very common under its ancient name NORIA. The Daniſh miſſionaries found in a remote village in the kingdom of Siam the immediate offspring of the noria (*Lettres Edifiantes et Curieuſes.*) It was a wheel turned by an aſs, and carrying round, not a ſtring of earthen pots, but a ſtring of wiſps of hay, which it drew through a wooden trunk. This rude chain-pump was in frequent uſe for watering the rice fields. It is highly probable that it is of great antiquity, although we do not recollect its being mentioned by any of the Greek or Roman writers. The Arabs and Indians were nothing leſs than innovators; and we may ſuppoſe with great ſafety, that what arts we now find among them they poſſeſſed in very remote periods. Now the ſtep from this to the pump is but ſhort, though it is nice and refined; and the forcing pump of Cteſibius is the eaſieſt and moſt natural.

Plate CCCCXXIV. 2 Cteſibius's pump.

Let AB (fig. 1.) be the ſurface of the water in the well, and D the height where it is to be delivered. Let DC be a long wooden trunk, reaching as deep under water as poſſible. Let the rope EF be fitted with its knot of hay F. When it is drawn up through the trunk, it will bring up along with it all the water lying between C and A, which will begin to run out by the ſpout D as ſoon as the knot gets to G, as far below D as C is below A. All this is very obvious; and it required but little reflection to be aſſured, that if F was let down again, or puſhed down, by a rod inſtead of a rope, it would again perform the ſame office. Here is a very ſimple pump. And if it was ever put in practice, it behoved to ſhow the ſupporting power of the atmoſphere, becauſe the water would not only be lifted by the knot, but would even follow it. The imperfection of this pump behoved to appear at firſt ſight, and to ſuggeſt its remedy. By puſhing down the knot F, which we ſhall henceforward call the *piſton*, all the force expended in lifting up the water between A and G is thrown away, becauſe it is again let down. A valve G, at the bottom, would prevent this. But then there muſt be a paſſage made for the water by a lateral tube KBD (fig. 2.) And if this be alſo furniſhed with a valve H, to prevent its loſing the water, we have the pump of Cteſibius, as ſketched in fig. 2. The valve is the great refinement: but perhaps even this had made its appearance before in the noria. For, in the more perfect kinds of theſe machines, the pots have a ſtop or valve in their bottom, which hangs open while the pot deſcends with its mouth downwards, and then allows it to fill readily in the ciſtern; whereas, without the valve, it would occaſion a double load to the wheel. If we ſuppoſe that the valve had made its appearance ſo early, it is not improbable that the common pump ſketched in fig. 3. was as old as that of Cteſibius. For a further deſcription of the pump of Cteſibius as it was uſed by the ancients, and of thoſe pumps which have been deduced from it and are now in common uſe, ſee HYDROSTATICS n° 28—32. In this place we ſhall firſt give a ſhort deſcription of the chief varieties of theſe engines, conſidering them in their ſimpleſt form, and we ſhall explain in very general terms their mode of operation. We ſhall then give a conciſe and popular theory of their operation, furniſhing principles to direct us in their conſtruction; and we ſhall conclude with the deſcription of a few peculiarities which may contribute to their improvement or perfection. Pump.

There are but two ſorts of pumps which eſſentially differ; and all the varieties that we ſee are only modifications of theſe. One of theſe original pumps has a ſolid piſton; the other has a piſton with a perforation and a valve. We uſually call the firſt a FORCING PUMP, and the ſecond a LIFTING or SUCKING PUMP.

3 Forcing pump deſcribed.

Fig. 2. is a ſketch of the forcing pump in its moſt ſimple form and ſituation. It conſiſts of a hollow cylinder AC*ca*, called the WORKING BARREL, open at both ends, and having a valve G at the bottom, opening upwards. This cylinder is filled by a ſolid piſton EF, covered externally with leather or tow, by which means it fits the box of the cylinder exactly, and allows no water to eſcape by its ſides. There is a pipe KHD, which communicates laterally with this cylinder, and has a valve at ſome convenient place H, as near as poſſible to its junction with the cylinder. This valve alſo opens upwards. This pipe, uſually called the RISING PIPE, or MAIN, terminates at the place D, where the water muſt be delivered.

4 Its mode of operation.

Now ſuppoſe this apparatus ſet into the water, ſo that the upper end of the cylinder may be under or even with the ſurface of the water AB; the water will open the valve G, and after filling the barrel and lateral pipe, will alſo open the valve H, and at laſt ſtand at an equal height within and without. Now let the piſton be put in at the top of the working barrel, and thruſt down to K. It will puſh the water before it. This will ſhut the valve G, and the water will make its way through the valve H, and fill a part B *b* of the riſing pipe, equal to the internal capacity of the working barrel. When this downward motion of the piſton ceaſes, the valve H will fall down by its own weight and ſhut this paſſage. Now let the piſton be drawn up again: The valve H hinders the water in the

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(A) In the early Greek writings, it does not appear that the words ἀντλος, ἀντλεῖν, ἀντλια, &c. were uſed to expreſs any thing like what we call a pump. In all theſe paſſages the words either expreſs generally the drawing of water, or, more particularly, the drawing it with a bucket or ſomething ſimilar. Ἀντλος, which is the primitive, is a drain, ſink, or receptacle for collecting ſcattered water, either for uſe, or to get rid of it; hence it came to ſignify the ſink or well of a ſhip; and ἀντλεῖν was ſynonymous with our verb "to bale the boat." (*Odyſſ.* O. 476. M. 411. *Euryp. Hecuba*, 1025). Ἀντλιον is the *veſſel* or *bucket* with which water is drawn. Ἀντλια is the ſervice (generally a puniſhment) of drawing water. Ἀντλεῖν, "to draw water with a bucket": hence the force of Ariſtotle's expreſſion (*Oecon.* 1) τω γαρ ἠθμῶ ἀντλειν τουτ' ἐστι. See even the late authority of the New Teſtament, John ii. 8.; iv. 7. 11. Here ἀντλημα is evidently ſomething which the woman brought along with her; probably a bucket and rope.

Pump. the rising pipe from returning into the working barrel. But now the valve G is opened by the pressure of the external water, and the water enters and fills the cylinder as the piston rises. When the piston has got to the top, let it be thrust down again: The valve G will again be shut, and the water will be forced through the passage at H, and rise along the main, pushing before it the water already there, and will now have its surface at L. Repeating this operation, the water must at last arrive at D, however remote, and the next stroke would raise it to *e*; so that during the next rise of the piston the water in *e*D will be running off by the spout.

The effect will be the same whatever is the position of the working barrel, provided only that it be under water. It may lie horizontally or sloping, or it may be with its mouth and piston rod undermost. It is still the same forcing pump, and operates in the same manner and by the same means, viz. the pressure of the surrounding water.

The external force which must be applied to produce this effect is opposed by the pressure exerted by the water on the opposite face of the piston. It is evident, from the common laws of hydrostatics, that this opposing pressure is equal to the weight of a pillar of water, having the face of the piston for its base, and the perpendicular height *d*A of the place of delivery above the surface of the water AB in the cistern for its height. The form and dimensions of the rising pipe are indifferent in this respect, because heavy fluids press only in the proportion of their perpendicular height. Observe that it is not *d*F, but *d*A, which measures this pressure, which the moving force must balance and surmount. The whole pressure on the under surface F*f* of the piston is indeed equal to the weight of the pillar *d*F*f*♂; but part of this is balanced by the water AF*fa*. If indeed the water does not get into the upper part of the working barrel, this compensation does not obtain. While we draw up the piston, this pressure is removed, because all communication is cut off by the valve H, which now bears the whole pressure of the water in the main. Nay, the ascent of the piston is even assisted by the pressure of the surrounding water. It is only during the descent of the piston therefore that the external force is necessary.

Observe that the measure now given of the external force is only what is necessary for *balancing* the pressure of the water in the rising pipe. But in order that the pump may perform work, it must *surmount* this pressure, and cause the water to issue at D with such a velocity that the required quantity of water may be delivered in a given time. This requires force, even although here were no opposing pressure; which would be the case if the main were horizontal. The water fills it, but it is at rest. In order that a gallon, for instance, may be delivered in a second, the whole water in the horizontal main must be put in motion with a certain velocity. This requires force. We must therefore always distinguish between the state of equilibrium and the state of actual working. It is the equilibrium only that we consider at present; and no more is necessary for understanding the operation of the different species of pumps. The other force is of much more intricate investigation, and will be considered by itself.

Pump. The simplest form and situation of the lifting pump is represented by the sketch fig. 3. The pump is immersed in the cistern till both the valve G and piston F are under the surface AB of the surrounding water. By this means the water enters the pump, opening both valves, and finally stands on a level within and without. 5 Lifting pump. 6

Its mode of operating. Now draw up the piston to the surface A. It must lift up the water which is above it (because the valve in the piston remains shut by its own weight); so that its surface will now be at *a*, A*a* being made equal to AF. In the mean time, the pressure of the surrounding water forces it into the working barrel, through the valve G; and the barrel is now filled with water. Now, let the piston be pushed down again; the valve G immediately shuts by its own weight, and in opposition to the endeavours which the water in the barrel makes to escape this way. This attempt to compress the water in the barrel causes it to open the valve F in the piston; or rather, this valve yields to our endeavour to push the piston down through the water in the working barrel. By this means we get the piston to the bottom of the barrel; and it has now above it the whole pillar of water reaching to the height *a*. Drawing up the piston to the surface A a second time, must lift this double column along with it, and its surface now will be at *b*. The piston may again be thrust down through the water in the barrel, and again drawn up to the surface; which will raise the water to *c*. Another repetition will raise it to *d*; and it will now show itself at the intended place of delivery. Another repetition will raise it to *e*; and while the piston is now descending to make another stroke, the water in *e d* will be running off through the spout D; and thus a stream will be produced, in some degree continual, but very unequal. This is inconvenient in many cases: thus, in a pump for domestic uses, such a hobbling stream would make it very troublesome to fill a bucket. It is therefore usual to terminate the main by a cistern LMNO, and to make the spout small. By this means the water brought up by the successive strokes of the piston rises to such a height in this cistern, as to produce an efflux by the spout nearly equable. The smaller we make the spout D the more equable will be the stream; for when the piston brings up more water than can be discharged during its descent, some of it remains in the cistern. This, added to the supply of next stroke, makes the water rise higher in the cistern than it did by the preceding stroke. This will cause the efflux to be quicker during the descent of the piston, but perhaps not yet sufficiently quick to discharge the whole supply. It therefore rises higher next stroke; and at last it rises so high, that the increased velocity of efflux makes the discharge precisely balance the supply. Now, the quantity supplied in each stroke is the same, and occupies the same room in the cistern at top; and the surface will sink the same number of inches during the descent of the piston, whether that surface has been high or low at the beginning. But because the velocities of the efflux are as the square roots of the heights of the water above the spout, it is evident that a sink of two or three inches will make a smaller change in the velocity of efflux when this height and velocity are great. This seems but a trifling observation; but it serves to illustrate a thing to be considered afterwards, which is important and abstruse, but perfectly similar to this.

Pump.

It is evident, that the force neceſſary for this operation muſt be equal to the weight of the pillar of water *d* A *a* D, if the pipe be perpendicular. If the pump be ſtanding aſlope, the preſſure which is to be balanced is ſtill equal to the weight of a pillar of water of this perpendicular height, and having the ſurface of the piſton for its baſe.

Such is the ſimpleſt, and, we may add, by far the beſt, form of the forcing and lifting pumps; but it is not the moſt uſual. Circumſtances of convenience, economy, and more frequently of fancy and habit, have cauſed the pump-makers to deviate greatly from this form. It is not uſual to have the working barrel in the water; this, eſpecially in deep wells, makes it of difficult acceſs for repairs, and requires long piſton rods. This would not do in a forcing pump, becauſe they would bend.

7 Effect of giving the piſton a longer ſtroke.

We have ſuppoſed, in our account of the lifting pump, that the riſe of the piſton always terminated at the ſurface of the water in the ciſtern. This we did in order that the barrel might always be filled by the preſſure of the ſurrounding water. But let us ſuppoſe that the riſe of the piſton does not end here, and that it is gradually drawn up to the very top: it is plain that the preſſure of the atmoſphere is by this means taken off from the water in the pipe (ſee PNEUMATICS), while it remains preſſing on the water of the ciſtern. It will therefore cauſe the water to follow the piſton as it riſes through the pipe, and it will raiſe it in this way 33 feet at a medium. If, therefore, the ſpout D is not more than 33 feet above the ſurface of the water in the ciſtern, the pipe will be full of water when the piſton is at D. Let it be puſhed down to the bottom; the water will remain in the pipe, becauſe the valve G will ſhut: and thus we may give the piſton a ſtroke of any length not exceeding 33 feet. If we raiſe it higher than this, the water will not follow; but it will remain in the pipe, to be lifted by the piſton, after it has been puſhed down through it to the bottom.

8 Inconvenient and unneceſſary.

But it is not neceſſary, and would be very inconvenient, to give the piſton ſo long a ſtroke. The great uſe of a pump is to render effectual the reciprocation of a ſhort ſtroke which we can command, while ſuch a long ſtroke is generally out of our power. Suppoſe that the piſton is puſhed down only to *b*; it will then have a column *b f* incumbent on it, and it will lift this column when again drawn up. And this operation may be repeated like the former, when the piſton was always under water; for the preſſure of the atmoſphere will always cauſe the water to follow the piſton to the height of 33 feet.

Nor is it neceſſary that the fixed valve G be placed at the lower orifice of the pipe, nor even under water. For, while things are in the ſtate now deſcribed, the piſton drawn up to *f*, and the whole pipe full of water; if we ſuppoſe another valve placed at *b* above the ſurface of the ciſtern, this valve can do no harm. Now let the piſton deſcend, both valves G and *b* will ſhut. G may now be removed, and the water will remain ſupported in the ſpace *b* G by the air; and now the alternate motions of the piſton will produce the ſame effect as before.

9 Effect of the weight of the water and preſſure of the atmoſphere.

We found in the former caſe that the piſton was carrying a load equal to the weight of a pillar of water of the height AD, becauſe the ſurrounding water could only ſupport it at its own level. Let us ſee what change is produced by the aſſiſtance of the preſſure of the atmoſphere. Let the under ſurface of the piſton be at *b*; when the piſton was at *f*, 33 feet above the ſurface of the ciſtern, the water was raiſed to that height by the preſſure of the atmoſphere. Suppoſe a partition made at *b* by a thin plate, and all the water above it taken away. Now pierce a hole in this plate. The preſſure of the atmoſphere was able to carry the whole column *f a*. Part of this column is now removed, and the remainder is not a balance for the air's preſſure. This will therefore cauſe the water to ſpout up through this hole and riſe to *f*. Therefore the under ſurface of this plate is preſſed up by the contiguous water with a force equal to the weight of that pillar of water which it formerly ſupported; that is, with a force equal to the weight of the pillar *f b*. Now, the under ſurface of the piſton, when at *b*, is in the ſame ſituation. It is preſſed upwards by the water below it, with a force equal to the weight of the column *f b*: But it is preſſed downwards by the whole preſſure of the atmoſphere, which preſſes on all bodies; that is, with the weight of the pillar *f a*. On the whole, therefore, it is preſſed downwards by a force equal to the difference of the weights of the pillars *f a* and *f b*; that is, by a force equal to the weight of the pillar *b a*.

It may be conceived better perhaps in this way. When the piſton was under the ſurface of the water in the ciſtern, it was equally preſſed on both ſides, both by the water and atmoſphere. The atmoſphere exerted its preſſure on it by the intervention of the water; which being, to all ſenſe, a perfect fluid, propagates every external preſſure undiminiſhed. When the piſton is drawn up above the ſurface of the pit-water, the atmoſphere continues to preſs on its upper ſurface with its whole weight, through the intervention of the water which lies above it; and its preſſure muſt therefore be added to that of the incumbent water. It alſo continues to preſs on the under ſurface of the piſton by the intervention of the water; that is, it preſſes this water to the piſton. But, in doing this, it carries the weight of this water which it is preſſing on the piſton. The preſſure on the piſton therefore is only the exceſs of the whole preſſure of the atmoſphere above the weight of the column of water which it is ſupporting. Therefore the difference of atmoſpheric preſſure on the upper and under ſurfaces of the piſton is preciſely equal to the weight of the column of water ſupported in the pipe by the air. It is not, however, the individual weight of this column that loads the piſton; it is the part of the preſſure of the atmoſphere on its upper ſurface, which is not balanced by its preſſure on the under ſurface.

In attempting therefore to draw up the piſton, we have to ſurmount this unbalanced part of the preſſure of the atmoſphere, and alſo the weight of the water which lies above the piſton, and muſt be lifted by it: and thus the whole oppoſing preſſure is the ſame as before, namely, the weight of the whole vertical pillar reaching from the ſurface of the water in the ciſtern to the place of delivery. Part of this weight is immediately carried by the preſſure of the atmoſphere; but, in lieu of it, there is an equal part of this preſſure of the atmoſphere abſtracted from the under ſurface of the piſton, while its upper ſurface ſuſtains its whole preſſure.

10 Other circumſtances to be attended to.

So far, then, theſe two ſtates of the pump agree.—But they differ exceedingly in their mode of operation; and there are ſome circumſtances not very obvious which muſt be attended to, in order that the pump may deli-

Pump.

ver any water at the ſpout D. This requires, therefore, a ſerious examination.

Let the fixed valve G (fig. 4.) be ſuppoſed at the ſurface of the ciſtern water. Let M *m* be the loweſt, and N *n* the higheſt, poſitions of the piſton, and let HA = *h* be the height of a column of water equiponderant with the atmoſphere.

When the pump is filled, not with water, but with air, and the piſton is in its loweſt poſition, and all in equilibrio, the internal air has the ſame denſity and elaſticity with the external. The ſpace MA *a m*, therefore, contains air of the common denſity and elaſticity. Theſe may be meaſured by *h*, or the weight of a column of water whoſe height is *h*. Now, let the piſton be drawn up to N *n*. The air which occupied the ſpace MA *a m* now occupies the ſpace NA *a n*, and its denſity is now $\frac{MA\ a\ m}{NA\ a\ n}$. Its elaſticity is now diminiſhed, being proportionable to its denſity (ſee PNEUMATICS), and no longer balances the preſſure of the atmoſphere. The valve G will therefore be forced up by the water, which will riſe to ſome height SA. Now let the piſton again deſcend to M *m*. It cannot do this with its valve ſhut; for when it comes down ſo far as to reduce the air again to its common denſity, it is not yet at M, becauſe the ſpace below it has been diminiſhed by the water which got into the pipe, and is retained there by the valve G. The piſton valve, therefore, opens by the air which we thus attempt to compreſs, and the ſuperfluous air eſcapes. When the piſton has got to M, the air is again of the common denſity, and occupies the ſpace MS *s m*. Now draw the piſton up to N. This air will expand into the ſpace NS *s n*, and its denſity will be reduced to $\frac{MS\ s\ m}{NS\ s\ n}$, and its elaſticity will no longer balance the preſſure of the atmoſphere, and more water will enter, and it will riſe higher. This will go on continually. But it may happen that the water will never riſe ſo high as to reach the piſton, even though not 33 feet above the water in the ciſtern: For the ſucceſſive diminutions of denſity and elaſticity are a ſeries of quantities that decreaſe geometrically, and therefore will have a limit. Let us ſee what determines this limit.

At whatever height the water ſtands in the lower part of the pipe, the weight of the column of water SA *a s*, together with the remaining elaſticity of the air above it, exactly balances the preſſure of the atmoſphere (ſee PNEUMATICS, n°108.) Now the elaſticity of the air in the ſpace NS *s n* is equal to $h \times \frac{MS\ s\ m}{NS\ s\ n}$. Therefore, in the caſe where the limit obtains, and the water riſes no farther, we muſt have $h = AS + h\frac{MS\ s\ m}{NS\ s\ n}$, or, becauſe the column is of the ſame diameter throughout, $h = AS + h\frac{MS}{NS}$ and $\frac{MS}{NS}h = h - AS$, = HS, and NS : MS = HA : HS, and NS — MS : NS = HA — HS : HA, or NM : NS = AS : AH, and NM×AH = NS×AS.— Therefore, if AN, the diſtance of the piſton in its higheſt poſition from the water in the ciſtern, and NM the length of its ſtroke, be given, there is a certain determined height AS to which the water can be raiſed by the preſſure of the air: For AH is a conſtant quantity; and therefore when MN is given, the rectangle AS×SN is given. If this height AS be leſs than that of the piſton in its loweſt poſition, the pump will raiſe no water, although AN may be leſs than AH. Yet the ſame pump will raiſe water very effectually, if it be firſt of all filled with water; and we have ſeen profeſſional engineers much puzzled by this capricious failure of their pumps. A little knowledge of the principles would have prevented their diſappointment.

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11 Mode of inſuring the delivery of water.

To inſure the delivery of water by the pump, the ſtroke muſt be ſuch that the rectangle MN×AH may be greater than any rectangle that can be made of the parts of AN, that is, greater than the ſquare of half AN. Or, if the length of the ſtroke be already fixed by other circumſtances, which is a common caſe, we muſt make AN ſo ſhort that the ſquare of its half, meaſured in feet, ſhall be leſs than 33 times the ſtroke of the piſton.

Suppoſe that the fixed valve, inſtead of being at the ſurface of the water in the ciſtern, is at S, or any where between S and A, the performance of the pump will be the ſame as before: But if it be placed anywhere above S, it will be very different. Let it be at T. It is plain that when the piſton is puſhed down from N to M, the valve at T prevents any air from getting down; and therefore, when the piſton is drawn up again, the air contained in the ſpace MT *t m* will expand into the ſpace NT *t n*, and its denſity will be $\frac{MT}{NT}$. This is leſs than $\frac{MS}{NS}$, which expreſſes the denſity of the air which was left in the ſpace TS *s t* by the former operations.— The air, therefore, in TS *s t* will alſo expand, will open the valve, and now the water will riſe above S. The proportion of NS to NT may evidently be ſuch that the water will even get above the valve T. This diminiſhes the ſpace NT *t n*; and therefore, when the piſton has been puſhed down to M, and again drawn up to N, the air will be ſtill more rarefied, and the water will riſe ſtill higher. The foregoing reaſoning, however, is ſufficient to ſhow that there may ſtill be a height which the water will not paſs, and that this height depends on the proportion between the ſtroke of the piſton and its diſtance from the water in the ciſtern. We need not give the determination, becauſe it will come in afterwards in combination with other circumſtances. It is enough that the reader ſees the phyſical cauſes of this limitation: And, laſtly, we ſee plainly that the utmoſt ſecurity will be given for the performance of the pump, when the fixed valve is ſo placed that the piſton, when in its loweſt poſition, ſhall come into contact with it. In this caſe, the rarefaction of the air will be the completeſt poſſible; and, if there were no ſpace left between the piſton and valve, and all were perfectly air-tight, the rarefaction would be complete, and the valve might be any thing leſs than 33 feet from the ſurface of the water in the ciſtern.

12 Valves not eaſily kept air-tight.

But this perfect contact and tightneſs is unattainable; and though the pump may be full of water, its continual downward preſſure cauſes it to filtrate ſlowly through every crevice, and the air enters through every pore, and even diſengages itſelf from the water, with which a conſiderable portion had been chemically combined. The pump by this means loſes water, and it requires ſeveral ſtrokes of briſk working to fill it again:

and

Pump. and if the leathers have become dry, ſo much admiſſion may be given to the air, that the pump will not fill itſelf with water by *any working*. It is then neceſſary to pour water into it, which ſhuts up theſe paſſages, and ſoon ſets all to rights again. For theſe reaſons, it is always prudent to place the fixed valve as low as other circumſtances will permit, and to make the piſton rod of ſuch a length, that when it is at the bottom of its ſtroke it ſhall be almoſt in contact with the valve. When we are not limited by other circumſtances, it is evident that the beſt poſſible form is to have both the piſton and the fixed valve under the ſurface of the water of the ciſtern. In this ſituation they are always wet and air-tight. The chief objection is, that by this diſpoſition they are not eaſily come at when needing repair. This is a material objection in deep mines. In ſuch ſituations, therefore, we muſt make the beſt compenſation of different circumſtances that we can. It is uſual to place the fixed valve at a moderate diſtance from the ſurface of the water, and to have a hole in the ſide of the pipe, by which it may be got out. This is carefully ſhut up by a plate firmly ſcrewed on, with leather or cement between the parts. This is called the *clack door*. It would, in every caſe, be very proper to have a fixed valve in the lower end of the pipe. This would combine all advantages. Being always tight, the pipe would retain the water, and it would leave to the valve above it its full effect of increaſing the rarefaction. A ſimilar hole is made in the working barrel, a little above the higheſt poſition of the piſton. When this needs repair, it can be got at through this hole, without the immenſe trouble of drawing up the whole rods.

Thus we have conducted the reader ſtep by ſtep, from the ſimpleſt form of the pump to that which long experience has at laſt ſelected as the moſt generally convenient. This we ſhall now deſcribe in ſome detail.

13 Deſcription of the ſucking-pump.

The SUCKING PUMP conſiſts of two pipes DCCD, BAAB (fig. 5.); of which the former is called the *Barrel*, or the *Working Barrel*, and the other is called the *Suction-pipe*, and is commonly of a ſmaller diameter.—Theſe are joined by means of ſtanches E, F, pierced with holes to receive ſcrewed bolts. A ring of leather, or of lead, covered with a proper cement, is put between them; which, being ſtrongly compreſſed by the ſcrew-bolts, renders the joint perfectly air-tight.—The lower end A of the ſuction-pipe is commonly ſpread out a little to facilitate the entry of the water, and frequently has a grating acroſs it at AA to keep out filth or gravel. This is immerged in the ſtanding water YZ. The working barrel is cylindrical, as evenly and ſmoothly bored as poſſible, that the piſton may fill it exactly through its whole length, and move along it with as little friction as may be conſiſtent with air-tightneſs.

The piſton is a ſort of truncated cone OPKL, generally made of wood not apt to ſplit, ſuch as elm or beech. The ſmall end of it is cut off at the ſides, ſo as to form a ſort of arch OQP, by which it is faſtened to the iron rod or ſpear. It is exhibited in different poſitions in figures 6, 7. which will give a more diſtinct notion of it than any deſcription. The two ends of the conical part may be hooped with braſs. This cone has its larger end ſurrounded with a ring or band of ſtrong leather faſtened with nails, or by a copper hoop, which is driven on it at the ſmaller end. This band ſhould reach to ſome diſtance beyond the baſe of the cone; the farther the better: and the whole muſt be of uniform thickneſs all round, ſo as to ſuffer equal compreſſion between the cone and the working barrel. The ſeam or joint of the two ends of this band muſt be made very cloſe, but not ſewed or ſtitched together. This would occaſion bumps or inequalities, which would ſpoil its tightneſs; and no harm can reſult from the want of it, becauſe the two edges will be ſqueezed cloſe together by the compreſſion in the barrel. It is by no means neceſſary that this compreſſion be great. This is a very detrimental error of the pump-makers. It occaſions enormous friction, and deſtroys the very purpoſe which they have in view, viz. rendering the piſton air-tight; for it cauſes the leather to wear through very ſoon at the edge of the cone, and it alſo wears the working barrel. This very ſoon becomes wide in that part which is continually paſſed over by the piſton, while the mouth remains of its original diameter, and it becomes impoſſible to thruſt in a piſton which ſhall completely fill the worn part. Now, a very moderate preſſure is ſufficient for rendering the pump perfectly tight, and a piece of glove leather would be ſufficient for this purpoſe, if looſe or detached from the ſolid cone; for ſuppoſe ſuch a looſe and flexible, but impervious, band of leather put round the piſton, and put into the barrel; and let it even be ſuppoſed that the cone does not compreſs it in the ſmalleſt degree to its internal ſurface.—Pour a little water carefully into the inſide of this ſort of cup or diſh; it will cauſe it to ſwell out a little, and apply itſelf cloſe to the barrel all round, and even adjuſt itſelf to all its inequalities. Let us ſuppoſe it to touch the barrel in a ring of an inch broad all round. We can eaſily compute the force with which it is preſſed. It is half the weight of a ring of water an inch deep and an inch broad. This is a trifle, and the friction occaſioned by it not worth regarding; yet this trifling preſſure is ſufficient to make the paſſage perfectly impervious, even by the moſt enormous preſſure of a high column of incumbent water: for let this preſſure be ever ſo great, the preſſure by which the leather adheres to the barrel always exceeds it, becauſe the incumbent fluid has no *preponderating* power by which it can force its way between them, and it muſt inſinuate itſelf preciſely ſo far, that its preſſure on the inſide of the leather ſhall ſtill exceed, and only exceed, the preſſure by which it endeavours to inſinuate itſelf; and thus the piſton becomes perfectly tight with the ſmalleſt poſſible friction. This reaſoning is perhaps too refined for the uninſtructed artiſt, and probably will not perſuade him. To ſuch we would recommend an examination of the piſtons and valves contrived and executed by that artiſt, whoſe ſkill far ſurpaſſes our higheſt conceptions, the all-wiſe Creator of this world. The valves which ſhut up the paſſages of the veins, and this in places where an extravaſation would be followed by inſtant death, are cups of thin membrane, which adhere to the ſides of the channel about half way round, and are detached in the reſt of their circumference. When the blood comes in the oppoſite direction, it puſhes the membrane aſide, and has a paſſage perfectly free. But a ſtagnation of motion allows the tone of the muſcular (perhaps) membrane, to reſtore it to its natural ſhape, and the leaſt *motion* in the oppoſite direction cauſes it inſtantly to clap cloſe to the ſides of the vein, and then no preſſure whatever can force a paſſage. We ſhall recur

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14 Neceſſity of air tightneſs not properly attended to.

15 An eaſy mode of rendering pumps tight.

16 Proved to be practicable from the human frame.

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to this again, when describing the various contrivances of valves, &c. What we have said is enough for supporting our directions for constructing a tight piston. But we recommended thick and strong leather, while our present reasoning seems to render thin leather preferable. If the leather be thin, and the solid piston in any part does not press it gently to the barrel, there will be in this part an unbalanced pressure of the incumbent column of water, which would instantly burst even a strong leather bag; but when the solid piston, covered with leather, exactly fills the barrel, and is even pressed a little to it, there is no such risk; and now that part of the leather band which reaches beyond the solid piston performs its office in the completest manner. We do not hesitate, therefore, to recommend this form of a piston, which is the most common and simple of all, as preferable, when well executed, to any of those more artificial, and frequently very ingenious, constructions, which we have met with in the works of the first engineers. To proceed, then, with our description of the sucking-pump.

17 Best form of a piston recommended.

18 Further description of the sucking-pump.

At the joining of the working barrel with the suction pipe there is a hole H, covered with a valve opening upwards. This hole H is either made in a plate which makes a part of the suction-pipe, being cast along with it, or it is made in a separate plate. This last is the most convenient, being easily removed and replaced. Different views are given of this valve in fig. 8, 9, 10. The diameter EF (fig. 10.) of this plate is the same with that of the flanches, and it has holes corresponding to them, through which their bolts pass which keep all together. A ring of thick leather NKL is applied to this plate, having a part cut out between N and L, to make room for another piece of strong leather NR (fig. 9.) which composes the valve. The circular part of this valve is broader than the hole in the middle of fig. 10. but not quite so broad as to fill up the inside of the ring of leather OQP of this fig. which is the same with GKI of fig. 10. The middle of this leather valve is strengthened by two brass (not iron) plates, the uppermost of which is seen at R of fig. 9: the one on its underside is a little smaller than the hole in the valve-plate, that it may go freely in; and the upper plate R is larger than this hole, that it may compress the leather to its brim all round. It is evident, that when this plate with its leathers is put between the joint flanches, and all is screwed together, the tail of leather N of fig. 9. will be compressed between the plates, and form a hinge, on which the valve can turn, rising and falling. There is a similar valve fastened to the upper side, or broadest base of the piston. This description serves for both valves, and in general for most valves which are to be found in any parts of a pump.

19 Its mode of operation.

The reader will now understand, without any repetition, the process of the whole operation of a sucking-pump. The piston rarefies the air in the working barrel, and that in the suction-pipe expands thro' the valve into the barrel; and, being no longer a balance for the atmospheric pressure, the water rises into the suction-pipe; another stroke of the piston produces a similar effect, and the water rises farther, but by a smaller step than by the preceding stroke: by repeating the strokes of the piston, the water gets into the barrel; and when the piston is now pushed down through it, it gets above the piston, and must now be lifted up to any height. The suction-pipe is commonly of smaller size than the working barrel, for the sake of economy. It is not necessary that it be so wide: but it may be, and often is, made too small. It should be of such a size, that the pressure of the atmosphere may be able to fill the barrel with water as fast as the piston rises. If a void is left below the piston, it is evident that the piston must be carrying the whole weight of the atmosphere, besides the water which is lying above it. Nay, if the pipe be only so wide, that the barrel shall fill precisely as fast as the piston rises, it must sustain all this pressure. The suction-pipe should be wider than this, that all the pressure of the atmosphere which exceeds the weight of the pillar in the suction-pipe may be employed in pressing it on the under surface of the piston, and thus diminish the load. It cannot be made too wide; and too strict an economy in this respect may very sensibly diminish the performance of the pump, and more than defeat its own purpose. This is most likely when the suction-pipe is long, because there the length of the pillar of water nearly balances the air's pressure, and leaves very little accelerating force; so that water will rise but slowly even in the widest pipe. All these things will be made the subjects of computation afterwards.

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It is plain that there will be limitations to the rise of the water in the suction-pipe, similar to what we found when the whole pump was an uniform cylinder. Let a be the height of the fixed valve above the water in the cistern: let B and b be the spaces in cubic measure between this valve and the piston in its highest and lowest positions, and therefore express the bulks of the air which may occupy these spaces: let y be the distance between the fixed valve and the water in the suction-pipe, when it has attained its greatest height by the rarefaction of the air above it: let b be the height of a column of water in equilibrio, with the whole pressure of the atmosphere, and therefore having its weight in equililibrio with the elasticity of common air: and let x be the height of the column whose weight balances the elasticity of the air in the suction-pipe, when rarefied as much as it can be by the action of the piston, the water standing at the height $a-y$.

Then, because this elasticity, together with the column $a-y$ in the suction-pipe, must balance the whole pressure of the atmosphere, (see PNEUMATICS, n° 108.), we must have $b = x + a - y$, and $y = a + x - b$.

When the piston was in its lowest position, the bulk of the air between it and the fixed valve was b. Suppose the valve kept shut, and the piston raised to its highest position, the bulk will be B, and its density $\frac{b}{B}$, and its elasticity, or the height of the column whose weight will balance it, will be $b\,\frac{b}{B}$. If the air in the suction-pipe be denser than this, and consequently more elastic, it will lift the valve, and some will come in; therefore, when the pump has rarefied the air as much as it can, so that none does, in fact, come in, the elasticity of the air in the suction-pipe *must* be the same. Therefore $x = b\,\frac{b}{B}$.

We

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We had $y = a + x - h$. Therefore $y = a + b\frac{b}{B} - h$, $= a + \frac{b - B}{B}h$, $= a - \frac{B - b}{B}h$.

Therefore when $\frac{B - b}{B}h$ is less than a, the water will stop before it reaches the fixed valve. But when a is less than $\frac{B - b}{B}h$, the water will get above the fixed valve, y becoming negative.

But it does not follow that the water will reach the piston, that is, will rise so high that the piston will pass through it in its descent. Things now come into the condition of a pump of uniform dimensions from top to bottom; and this point will be determined by what was said when treating of such a pump.

20 The same pump is used in an inverted position;

There is another form of the sucking pump which is much used in great water works, and is of equal efficacy with the one now described. It is indeed the same pump in an inverted position. It is represented in fig. 11. where ABCD is the working barrel, immersed, with its mouth downwards, in the water of the cistern. It is joined by means of flanches to the rising pipe or MAIN.

This usually consists of two parts. The first, BEFC, is bent to one side, that it may give room for the iron frames TXYV, which carries the rod NO of the piston M, attached to the traverses RS, TOV of this frame. The other part, EGHF, is usually of a less diameter, and is continued to the place of delivery. The piston frame XTVY hangs by the rod Z, at the arm of a lever or working beam, not brought into the figure. The piston is perforated like the former, and is surrounded like it with a band of leather in form of a taper-dish. It has a valve K on its broad or upper base, opening when pressed from below. The upper end of the working barrel is pierced with a hole, covered with a valve I, also opening upwards.

Now suppose this apparatus immersed into the cistern till the water is above it, as marked by the line 2, 3, and the piston drawn up till it touch the end of the barrel. When the piston is allowed to descend by its own weight, the water rises up through its valve K, and fills the barrel. If the piston be now drawn up by the moving power of the machinery with which it is connected, the valve K shuts, and the piston pushes the water before it through the valve I into the main pipe EFGH. When the piston is again let down, the valve I shuts by its own weight and the pressure of the water incumbent on it, and the barrel is again filled by the water of the cistern. Drawing up the piston pushes this water into the main pipe, &c. and then the water is at length delivered at the place required.

21 And is called a *lifting pump*.

This pump is usually called the *lifting pump*; perhaps the simplest of all in its principle and operation.—It needs no farther explanation: and we proceed to describe

22 Forcing-pump described.

The FORCING PUMP, represented in fig. 12. It consists of a working barrel ABCD, a suction-pipe CDEF, and a main or rising pipe. This last is usually in three joints. The first GHKI may be considered as making part of the working barrel, and is commonly cast in one piece with it. The second IKLM is joined to it by flanches, and forms the elbow which this pipe must generally have. The third LNOM is properly the beginning of the main, and is continued to the place of delivery. At the joint IK there is a hanging valve or clack S; and there is a valve R on the top of the suction-pipe. Pump.

The piston PQTV is solid, and is fastened to a stout iron rod which goes through it, and is fixed by a key drawn through its end. The body of the piston is a sort of double cone, widening from the middle to each end, and is covered with two bands of very strong leather, fitted to it in the manner already described.

23 Its mode of operation

The operation of this pump is abundantly simple. When the piston is thrust into the pump, it pushes the air before it through the valve S, for the valve R remains shut by its own weight. When it has reached near the bottom, and is drawn up again, the air which filled the small space between the piston and the valve S now expands into the barrel; for as soon as the air begins to expand, it ceases to balance the pressure of the atmosphere, which therefore shuts the valve S. By the expansion of the air in the barrel the equilibrium at the valve R is destroyed, and the air in the suction-pipe lifts the valve, and expands into the barrel; consequently it ceases to be a balance for the pressure of the atmosphere, and the water is forced into the suction-pipe. Pushing the piston down again forces the air in the barrel through the valve S, the valve R in the mean time shutting. When the piston is again drawn up, S shuts, R opens, the air in the suction-pipe dilates anew, and the water rises higher in it. Repeating these operations, the water gets at last into the working barrel, and is forced into the main by pushing down the piston, and is pushed along to the place of delivery.

24 Is two fold.

The operation of this pump is therefore two-fold, sucking and forcing. In the first operation, the same force must be employed as in the sucking-pump, namely, a force equal to the weight of a column of water having the section of the piston for its base, and the height of the piston above the water in the cistern for its height. It is for the sake of this part of the operation that the upper cone is added to the piston. The air and water would pass by the sides of the lower cone while the piston is drawn up; but the leather of the upper cone applies to the surface of the barrel, and prevents this. The space contained between the barrel and the valve S is a great obstruction to this part of the operation, because this air cannot be rarefied to a very great degree. For this reason, the suction-pipe of a forcing-pump must not be made long. It is not indeed necessary; for by placing the pump a few feet lower, the water will rise into it without difficulty, and the labour of suction is as much diminished as that of impulsion is increased. However, an intelligent artist will always endeavour to make this space between the valve S and the lowest place of the piston as small as possible.

The power employed in forcing must evidently surmount the pressure of the whole water in the rising pipe, and (independent of what is necessary for giving the water the required velocity, so that the proper quantity per hour may be delivered), the piston has to withstand a force equal to the weight of a column of water having the section of the piston for its base, and the perpendicular altitude of the place of delivery above the lower surface of the piston for its height. It is quite

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quite indifferent in this reſpect what is the diameter of the riſing pipe; becauſe the preſſure on the piſton depends on the altitude of the water only, independent of its quantity. We ſhall even ſee that a ſmall riſing pipe will require a greater force to convey the water along it to any given height or diſtance.

When we would employ a pump to raiſe water in a crooked pipe, or in any pipe of moderate dimenſions, this form of pump, or ſomething equivalent, muſt be uſed. In bringing up great quantities of water from mines, the common ſucking-pump is generally employed, as really the beſt of them all: but it is the moſt expenſive, becauſe it requires the pipe to be perpendicular, ſtraight, and of great dimenſions, that it may contain the piſton rods. But this is impracticable when the pipe is crooked.

If the forcing pump, conſtructed in the manner now deſcribed, be employed, we cannot uſe forcers with long rods. Theſe would bend when puſhed down by their further extremity. In this caſe, it is uſual to employ only a ſhort and ſtiff rod, and to hang it by a chain, and load it with a weight ſuperior to the weight of water to be raiſed by it. The machinery therefore is employed, not in forcing the water along the riſing-pipe, but in raiſing the weight which is to produce this effect by its ſubſequent deſcent.

In this caſe, it would be much better to employ the lifting-pump of fig. 11. For as the load on the forcers muſt be greater than the reſiſtances which it muſt ſurmount, the force exerted by the machine muſt in like manner be greater than this load. This double exceſs would be avoided by uſing the lifting-pump.

25 Meaſure of the quantity of water delivered by any pump.

It will readily occur to the reader that the quantity of water delivered by any pump will be in the joint proportion of the ſurface or baſe of the piſton and its velocity: for this meaſures the capacity of that part of the working barrel which the piſton paſſes over. The velocity of the water in the conduit pipe, and in its paſſage through every valve, will be greater or leſs than the velocity of the piſton in the ſame proportion that the area of the piſton or working barrel is greater or leſs than the area of the conduit or valve. For whatever quantity of water paſſes through any ſection of the working-barrel in a ſecond, the ſame quantity muſt go through any one of theſe paſſages. This enables us to modify the velocity of the water as we pleaſe: we can increaſe it to any degree at the place of delivery by diminiſhing the aperture through which it paſſes, provided we apply ſufficient force to the piſton.

26 The operation of pumps not equable;

It is evident that the operation of a pump is by ſtarts, and that the water in the main remains at reſt, preſſing on the valve during the time that the piſton is withdrawn from the bottom of the working barrel. It is in moſt caſes deſirable to have this motion equable, and in ſome caſes it is abſolutely neceſſary. Thus, in the engine for extinguiſhing fires, the ſpout of water going by jerks could never be directed with a certain aim, and half of the water would be loſt by the way; becauſe a body at reſt cannot in an inſtant be put in rapid motion, and the firſt portion of every jerk of water would have but a ſmall velocity. A very ingenious contrivance has been fallen upon for obviating this inconvenience, and procuring a ſtream nearly equable. We have not been able to diſcover the author. At any convenient part of the riſing pipe beyond the valve S there is annexed a capacious veſſel VZ (fig. 13. n° 1 and 2.) cloſe atop, and of great ſtrength. When the water is forced along this pipe, part of it gets into this veſſel, keeping the air confined above it, and it fills it to ſuch a height V, that the elaſticity of the confined air balances a column reaching to T, we ſhall ſuppoſe, in the riſing pipe. The next ſtroke of the piſton ſends forward more water, which would fill the riſing pipe to ſome height above T. But the preſſure of this additional column cauſes ſome more of it to go into the air veſſel, and compreſs its air ſo much more that its elaſticity now balances a longer column. Every ſucceeding ſtroke of the piſton produces a like effect. The water riſes higher in the main pipe, but ſome more of it goes into the air-veſſel. At laſt the water *appears* at the place of delivery; and the air in the air-veſſel is now ſo much compreſſed that its elaſticity balances the preſſure of the whole column. The next ſtroke of the piſton ſends forward ſome more water. If the diameter of the orifice of the main be ſufficient to let the water flow out with a velocity equal to that of the piſton, it will ſo flow out, riſing no higher, and producing no ſenſible addition to the compreſſion in the air-veſſel. But if the orifice of the main be contracted to half its dimenſions, the water ſent forward by the piſton cannot flow out in the time of the ſtroke without a greater velocity, and therefore a greater force. Part of it, therefore, goes into the air-veſſel, and increaſes the compreſſion. When the piſton has ended its ſtroke, and no more water comes forward, the compreſſion of the air in the air-veſſel being greater than what was ſufficient to balance the preſſure of the water in the main pipe, now forces out ſome of the water which is lying below it. This cannot return towards the pump, becauſe the valve S is now ſhut. It therefore goes forward along the main, and produces an efflux during the time of the piſton's riſing in order to make another ſtroke. In order that this efflux may be very equable, the air-veſſel muſt be very large. If it be ſmall, the quantity of water that is diſcharged by it during the return of the piſton makes ſo great a portion of its capacity, that the elaſticity of the confined air is too much diminiſhed by this enlargement of its bulk, and the rate of efflux muſt diminiſh accordingly. The capacity of the air-veſſel ſhould be ſo great that the change of bulk of the compreſſed air during the inaction of the piſton may be inconſiderable. It muſt therefore be very ſtrong.

27 And the mode of making them ſo.

It is pretty indifferent in what way this air-veſſel is connected with the riſing pipe. It may join it laterally, as in fig. 13. n° 1. and the main pipe go on without interruption; or it may be made to *ſurround* an interruption of the main pipe, as in fig. 13. n° 2. It may alſo be in any part of the main-pipe. If the ſole effect intended by it is to produce an equable jet, as in ornamental water-works, it may be near the end of the main. This will require much leſs ſtrength, becauſe there remains but a ſhort column of water to compreſs the air in it. But it is, on the whole, more advantageous to place it as near the pump as poſſible, that it may produce an equable motion in the whole main-pipe. This is of conſiderable advantage: when a column of water ſeveral hundred feet long is at reſt in the main-pipe, and the piſton at one end of it put at once into motion,

even

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even with a moderate velocity, the ſtrain on the pipe would be very great. Indeed if it were poſſible to put the piſton inſtantaneouſly into motion with a finite velocity, the ſtrain on the pipe, tending to burſt it, would be next to infinite. But this ſeems impoſſible in nature; all changes of motion *which we obſerve* are gradual, becauſe all impelling bodies have ſome elaſticity or ſoftneſs by which they yield to compreſſion. And, in the way in which piſtons are commonly moved, *viz.* by cranks, or ſomething analogous to them, the motion is *very ſenſibly* gradual. But ſtill the air-veſſel tends to make the motion along the main-pipe leſs deſultory, and therefore diminiſhes thoſe ſtrains which would really take place in the main-pipe. It acts like the ſprings of a travelling carriage, whoſe jolts are incomparably leſs than thoſe of a cart; and by this means really enables a given force to propel a greater quantity of water in the ſame time.

28 The deſultory motion of the piſtons

29 Corrected.

We may here by the way obſerve, that the attempts of mechanicians to correct this unequal motion of the piſton-rod are miſplaced, and if it could be done, would greatly hurt a pump. One of the beſt methods of producing this effect is to make the piſton-rod conſiſt of two parallel bars, having teeth in the ſides which front each other. Let a toothed wheel be placed between them, having only the half of its circumference furniſhed with teeth. It is evident, without any farther deſcription, that if this wheel be turned uniformly round its axis, the piſton-rod will be moved uniformly up and down without intermiſſion. This has often been put in practice; but the machine always went by jolts, and ſeldom laſted a few days. Unſkilled mechanicians attributed this to defect in the execution: but the fault is eſſential, and lies in the principle.

30 But on a wrong principle.

The machine could not perform one ſtroke, if the firſt mover did not ſlacken a little, or the different parts of the machine did not yield by bending or by compreſſion; and no ſtrength of materials could withſtand the violence of the ſtrains at every reciprocation of the motion. This is chiefly experienced in great works which are put in motion by a water-wheel, or ſome other equal power exerted on the maſs of matter of which the machine conſiſts. The water-wheel being of great weight, moves with conſiderable ſteadineſs or uniformity; and when an additional reſiſtance is oppoſed to it by the beginning of a new ſtroke of the piſton, its great quantity of motion is but little affected by this addition, and it proceeds very little retarded; and the machine muſt either yield a little by bending and compreſſion, or go to pieces, which is the common event. Cranks are free from this inconvenience, becauſe they accelerate the piſton gradually, and bring it gradually to reſt, while the water-wheel moves round with almoſt perfect uniformity. The only inconvenience (and it may be conſiderable) attending this ſlow motion of the piſton at the beginning of its ſtroke is, that the valves do not ſhut with rapidity, ſo that ſome water gets back through them. But when they are properly formed and loaded, this is but trifling.

31 Theſe equable pumps deliver very little more water than the others.

We muſt not imagine, that becauſe the ſtream produced by the aſſiſtance of an air-barrel is almoſt perfectly equable, and becauſe as much water runs out during the returning of the piſton as during its active ſtroke, it therefore doubles the quantity of water. No more water can run out than what is ſent forward by the piſton during its effective ſtroke. The continued ſtream is produced only by preventing the whole of this water from being diſcharged during this time, and by providing a propelling force to act during the piſton's return. Nor does it enable the moving force of the piſton to produce a double effect: for the compreſſion which is produced in the air-veſſel, more than what is neceſſary for merely balancing the quieſcent column of water, reacts on the piſton, reſiſting its compreſſion juſt as much as the column of water would do which produces a velocity equal to that of the efflux. Thus if the water is made to ſpout with the velocity of eight feet per ſecond, this would require an additional column of one foot high, and this would juſt balance the compreſſion in the air-veſſel, which maintains this velocity during the non-action of the piſton. It is, however, a matter of fact, that a pump furniſhed with an air-veſſel delivers a little more water than it would do without it. But the difference depends on the combination of many very diſſimilar circumſtances, which it is extremely difficult to bring into calculation. Some of theſe will be mentioned afterwards.

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To deſcribe, or even to enumerate, the immenſe variety of combinations of theſe three ſimple pumps would fill a volume. We ſhall ſelect a few, which are more deſerving of notice.

32 The ſucking pump converted into a lifting pump.

I. The common ſucking-pump may, by a ſmall addition, be converted into a lifting-pump, fitted for propelling the water to any diſtance, and with any velocity.

Fig. 14. is a ſucking-pump, whoſe working-barrel ACDB has a lateral pipe AEGHF connected with it cloſe to the top. This terminates in a *main* or riſing pipe IK, furniſhed or not with a valve L. The top of the barrel is ſhut up by a ſtrong plate MN, having a hollow neck terminating in a ſmall flanch. The piſton rod QR paſſes through this neck, and is nicely turned and poliſhed. A number of rings of leather are put over the rod, and ſtrongly compreſſed round it by another flanch and ſeveral ſcrewed bolts, as is repreſented at OP. By this contrivance the rod is cloſely graſped by the leathers, but may be eaſily drawn up and down, while all paſſage of air or water is effectually prevented.

The piſton S is perforated, and furniſhed with a valve opening upwards. There is alſo a valve T on the top of the ſuction-pipe YX; and it will be of advantage, though not abſolutely neceſſary, to put a valve L at the bottom of the riſing pipe. Now ſuppoſe the piſton at the bottom of the working-barrel. When it is drawn up, it tends to compreſs the air above it, becauſe the valve in the piſton remains ſhut by its own weight. The air therefore is driven through the valve L into the riſing pipe, and eſcapes. In the mean time, the air which occupied the ſmall ſpace between the piſton and the valve T expands into the upper part of the working barrel; and its elaſticity is ſo much diminiſhed thereby, that the atmoſphere preſſes the water of the ciſtern into the ſuction-pipe, where it will riſe till an equilibrium is again produced. The next downward ſtroke of the piſton allows the air, which had come from the ſuction-pipe into the barrel during the aſcent of the piſton, to get through its valve. Upon drawing up the piſton, this air is alſo drawn off through the riſing pipe. Repeating this proceſs brings the wa-

Pump.

ter at laſt into the working-barrel, and it is then driven along the riſing-pipe by the piſton.

33 Advantages of this converſion.

This is one of the beſt forms of a pump. The rarefaction may be very perfect, becauſe the piſton can be brought ſo near to the bottom of the working-barrel: and, for forcing water in oppoſition to great preſſures, it appears preferable to the common forcing-pump; becauſe in that the piſton rods are compreſſed and expoſed to bending, which greatly hurts the pump by wearing the piſton and barrel on one ſide. This ſoon renders it leſs tight, and much water ſquirts out by the ſides of the piſton. But in this pump the piſton rod is always drawn or pulled, which keeps it ſtraight; and rods exert a much greater force in oppoſition to a pull than in oppoſition to compreſſion. The collar of leather round the piſton-rods is found by experience to need very little repairs, and is very impervious to water. The whole is very acceſſible for repairs; and in this reſpect much preferable to the common pump in deep mines, where every fault of the piſton obliges us to draw up ſome hundred feet of piſton-rods. By this addition, too, any common pump for the ſervice of a houſe is converted into an engine for extinguiſhing fire, or may be made to convey the water to every part of the houſe; and this without hurting or obſtructing its common uſes. All that is neceſſary is to have a large cock on the upper part of the working barrel oppoſite to the lateral pipe in this figure. This cock ſerves for a ſpout when the pump is uſed for common purpoſes; and the merely ſhutting this cock converts the whole into an engine for extinguiſhing fire or for ſupplying diſtant places with water. It is ſcarcely neceſſary to add, that for theſe ſervices it will be proper to connect an air-veſſel with ſome convenient part of the riſing pipe, in order that the current of the water may be continual.

34 Equable ſtreams produced in great works by combinations.

We have frequently ſpoken of the advantages of a continued current in the main pipe. In all great works a conſiderable degree of uniformity is produced by the manner of diſpoſing the actions of the different pumps; for it is very rarely that a machine works but one pump. In order to maintain ſome uniformity in the reſiſtance, that it may not all be oppoſed at once to the moving power, with intervals of total inaction, which would produce a very hobbling motion, it is uſual to diſtribute the work into portions, which ſucceed alternately; and thus both diminiſh the ſtrain, and give greater uniformity of action, and frequently enable a natural power which we can command, to perform a piece of work, which would be impoſſible if the whole reſiſtance were oppoſed at once. In all pump machines therefore we are obviouſly directed to conſtruct them ſo that they may give motion to at leaſt two pumps, which work alternately. By this means a much greater uniformity of current is produced in the main pipe. It will be rendered ſtill more uniform if four are employed, ſucceeding each other at the interval of one quarter of the time of a complete ſtroke.

35 A ſingle pump for this purpoſe deſcribed.

But ingenious men have attempted the ſame thing with a ſingle pump, and many different conſtructions for this purpoſe have been propoſed and executed. The thing is not of much importance, nor of great reſearch. We ſhall content ourſelves therefore with the deſcription of one that appears to us the moſt perfect, both in reſpect of ſimplicity and effect.

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II. It conſiſts of a working-barrel AB (fig. 15.) cloſe at both ends. The piſton C is ſolid, and the rod OP paſſes through a collar of leathers in the plate, which cloſes the upper end of the working-barrel. This barrel communicates laterally with two pipes H, K; the communications *m* and *n* being as near to the top and bottom of the barrel as poſſible. Adjoining to the paſſage *m* are two valves F and G opening upwards. Similar valves accompany the paſſage *n*. The two pipes H and K unite in a larger riſing pipe L. They are all repreſented as in the ſame plane; but the upper ends muſt be bent backwards, to give room for the motion of the piſton-rod OP.

Suppoſe the piſton cloſe to the entry of the lateral pipe *n*, and that it is drawn up: it compreſſes the air above it, and drives it through the valve G, where it eſcapes along the riſing pipe; at the ſame time it rarefies the air in the ſpace below it. Therefore the weight of the atmoſphere ſhuts the valve E, and cauſes the water of the ciſtern to riſe through the valve D, and fill the lower part of the pump. When the piſton is puſhed down again, this water is firſt driven through the valve E, becauſe D immediately ſhuts; and then moſt of the air which was in this part of the pump at the beginning goes up through it, ſome of the water coming back in its ſtead. In the mean time, the air which remained in the upper part of the pump after the aſcent of the piſton is rarefied by its deſcent; becauſe the valve G ſhuts as ſoon as the piſton begins to deſcend, the valve F opens, the air in this ſuction pipe F*f* expands into the barrel, and the water riſes into the pipes by the preſſure of the atmoſphere. The next riſe of the piſton muſt bring more water into the lower part of the barrel, and muſt drive a little more air through the valve G, namely, part of that which had come out of the ſuction-pipe F*f*; and the next deſcent of the piſton muſt drive more water into the riſing pipe H, and along with it moſt if not all of the air which remained below the piſton, and muſt rarefy ſtill more the air remaining above the piſton; and more water will come in through the pipe F*f*, and get into the barrel. It is evident that a few repetitions will at laſt fill the barrel on both ſides of the piſton with water. When this is accompliſhed, there is no difficulty in perceiving how, at every riſe of the piſton, the water of the ciſtern will come in by the valve D, and the water in the upper part of the barrel will be driven thro' the valve G; and, in every deſcent of the piſton, the water of the ciſtern will come into the barrel by the valve F, and the water below the piſton will be driven through the valve E: and thus there will be a continual influx into the barrel through the valves D and F, and a continual diſcharge along the riſing pipe L through the valves E and G.

36 It is equivalent to two forcing-pumps.

This machine is, to be ſure, equivalent to two forcing pumps, although it has but one barrel and one piſton; but it has no ſort of ſuperiority. It is not even more economical in moſt caſes; becauſe we apprehend that the additional workmanſhip will fully compenſate for the barrel and piſton that is ſaved. There is indeed a ſaving in the reſt of the machinery, becauſe one lever produces both motions. We cannot therefore ſay that it is inferior to two pumps; and we acknowledge that there is ſome ingenuity in the contrivance.

We recommend to our readers the peruſal of Belidor's

Pump. dor's *Architecture Hydraulique*, where is to be found a great variety of combinations and forms of the ſimple pumps; but we muſt caution them with reſpect to his theories, which in this article are extremely defective. Alſo in Leupold's *Theatrum Machinarum Hydraulicarum*, there is a prodigious variety of all kinds of pumps, many of them very ſingular and ingenious, and many which have particular advantages, which may ſuit local circumſtances, and give them a preference. But it would be improper to ſwell a work of this kind with ſo many peculiarities; and a perſon who makes himſelf maſter of the principles delivered here in ſufficient detail, can be at no loſs to ſuit a pump to his particular views, or to judge of the merit of ſuch as may be propoſed to him.

37 Authors recommended.

We muſt now take notice of ſome very conſiderable and important varieties in the form and contrivance of the eſſential parts of a pump.

38 The forcing pump differently conſtructed. Plate ccccxxv.

III. The forcing pump is ſometimes of a very different form from that already deſcribed. Inſtead of a piſton, which applies itſelf to the inſide of the barrel, and ſlides up and down in it, there is a long cylinder POQ (*fig. 16.*) nicely turned and poliſhed on the outſide, and of a diameter ſomewhat leſs than the inſide of the barrel. This cylinder (called a PLUNGER) ſlides through a collar of leathers on the top of the working-barrel, and is conſtructed as follows. The top of the barrel terminates in a flanch *a b*, pierced with four holes for receiving ſcrew-bolts. There are two rings of metal, *c d*, *e f*, of the ſame diameter, and having holes correſponding to thoſe in the flanch. Four rings of ſoft leather, of the ſame ſize, and ſimilarly pierced with holes, are well ſoaked in a mixture of oil, tallow, and a little roſin. Two of theſe leather rings are laid on the pump flanch, and one of the metal rings above them. The plunger is then thruſt down through them, by which it turns their inner edges downwards. The other two rings are then ſlipped on at the top of the plunger, and the ſecond metal ring is put over them, and then the whole are ſlid down to the metal ring. By this the inner edges of the laſt leather rings are turned upwards. The three metal rings are now forced together by the ſcrewed bolts; and thus the leathern rings are ſtrongly compreſſed between them, and made to graſp the plunger ſo cloſely that no preſſure can force the water through between. The upper metal ring juſt allows the plunger to paſs through it, but without any play; ſo that the turned up edges of the leathern rings do not come up between the plunger and the upper metal ring, but are lodged in a little conical taper, which is given to the inner edge of the upper plate, its hole being wider below than above. It is on this trifling circumſtance that the great tightneſs of the collar depends. To prevent the leathers from ſhrinking by drought, there is uſually a little ciſtern formed round the head of the pump, and kept full of water. The plunger is either forced down by a rod from a working beam, or by a ſet of metal-weights laid on it, as is repreſented in the figure.

39 Its mode of operation.

It is hardly neceſſary to be particular in explaining the operation of this pump. When the plunger is at the bottom of the barrel, touching the fixed valve M with its lower extremity, it almoſt completely fills it. That it may do it completely, there is ſometimes a ſmall pipe RSZ branching out from the top of the barrel, and fitted with a cock at S. Water is admitted till the barrel is completely filled, and the cock is then ſhut. Now when the plunger is drawn up, the valve N in the riſing pipe muſt remain ſhut by the preſſure of the atmoſphere, and a void muſt be made in the barrel. Therefore the valve M on the top of the ſuction-pipe muſt be opened by the elaſticity of the air in this pipe, and the air muſt expand into the barrel; and, being no longer a balance for the atmoſphere, the water in the ciſtern muſt be forced into the ſuction-pipe, and riſe in it to a certain height. When the plunger deſcends, it muſt drive the water through the valve N (for the valve M will immediately ſhut), and along with it moſt of the air which had come into the barrel. And as this air occupied the upper part of the barrel, part of it will remain when the plunger has reached the bottom; but a ſtroke or two will expel it all, and then every ſucceeding ſtroke of the deſcending piſton will drive the water along the riſing pipe, and every aſcent of the plunger will be followed by the water from the ciſtern. Pump.

The advantage propoſed by this form of piſton is, that it may be more accurately made and poliſhed than the inſide of a working barrel, and it is of much eaſier repair. Yet we do not find that it is much uſed, although an invention of laſt century (we think by Sir Samuel Morland), and much praiſed by the writers on theſe ſubjects.

40 Sucking-pump ſimilarly varied.

It is eaſy to ſee that the ſucking-pump may be varied in the ſame way. Suppoſe this plunger to be open both at top and bottom, but the bottom filled with a valve opening upward. When this is puſhed to the bottom of the barrel, the air which it tends to compreſs lifts the valve (the lateral pipe FIK being taken away and the paſſage ſhut up), and eſcapes through the plunger. When it is drawn up, it makes the ſame rarefaction as the ſolid plunger, becauſe the valve at O ſhuts, and the water will come up from the ciſtern as in the former caſe. If the plunger be now thruſt down again, the valve M ſhuts, the valve O is forced open, and the plunger is filled with water. This will be lifted by it during its next aſcent; and when it is puſhed down again, the water which filled it muſt now be puſhed out, and will flow over its ſides into the ciſtern at the head of the barrel. Inſtead of making the valve at the bottom of the piſton, it may be made at the top; but this diſpoſition is much inferior, becauſe it cannot rarefy the air in the barrel one half. This is evident; for the capacity of the barrel and plunger together cannot be twice the capacity of the barrel.

41 Another form of the ſucking-pump.

IV. It may be made after a ſtill different form, as repreſented in fig. 17. Here the ſuction-pipe CO comes up through a ciſtern KMNL deeper or longer than the intended ſtroke of the piſton, and has a valve C at top. The piſton, or what acts in lieu of it, is a tube AHGB, open at both ends, and of a diameter ſomewhat larger than that of the ſuction-pipe. The interval between them is filled up at HG by a ring or belt of ſoft leather, which is faſtened to the *outer* tube, and moves up and down with it, ſliding along the ſmoothly poliſhed ſurface of the ſuction-pipe with very little friction. There is a valve I on the top of this piſton, opening upwards. Water is poured into the outer ciſtern.

42 And its mode of operation.

The outer cylinder or piſton being drawn up from the bottom, there is a great rarefaction of the air which was

Pump. was between them, and the atmoſphere preſſes the water up through the ſuction-pipe to a certain height; for the valve I keeps ſhut by the preſſure of the atmoſphere and its own weight. Puſhing down the piſton cauſes the air, which had expanded from the ſuction-pipe into the piſton, to eſcape through the valve I; drawing it up a ſecond time, allows the atmoſphere to preſs more water into the ſuction-pipe, to fill it, and alſo part of the piſton. When this is puſhed down again, the water which had come through the valve C is now forced out through the valve I into the ciſtern KMNL, and now the whole is full of water. When, therefore, the piſton is drawn up, the water follows, and fills it, if not 33 feet above the water in the ciſtern; and when it is puſhed down again, the water which filled the piſton is all thrown out into the ciſtern; and after this it delivers its full contents of water every ſtroke. The water in the ciſtern KMNL effectually prevents the entry of any air between the two pipes; ſo that a very moderate compreſſion of the belt of ſoft leather at the mouth of the piſton cylinder is ſufficient to make all perfectly tight.

43 The piſton cylinder differently formed.

It might be made differently. The ring of leather might be faſtened round the top of the inner cylinder at DE, and ſlide on the inſide of the piſton cylinder; but the firſt form is moſt eaſily executed. Muſchenbroeck has given a figure of this pump in his large ſyſtem of natural philoſophy, and ſpeaks very highly of its performance. But we do not ſee any advantage which it poſſeſſes over the common ſucking-pump. He indeed ſays that it is without friction, and makes no mention of the ring of leather between the two cylinders. Such a pump will raiſe water extremely well to a ſmall height, and it ſeems to have been a model only which he had examined: But if the ſuction-pipe is long, it will by no means do without the leather; for on drawing up the piſton, the water of the upper ciſtern will riſe between the pipes, and fill the piſton, and none will come up through the ſuction-pipe.

44 Pumps without friction not of important uſe.

We may take this opportunity of obſerving, that the many ingenious contrivances of pumps without friction are of little importance in great works; becauſe the friction which is completely ſufficient to prevent all eſcape of water in a well-conſtructed pump is but a very trifling part of the whole force. In the great pumps which are uſed in mines, and are worked by a ſteam-engine, it is very uſual to make the piſtons and valves without any leather whatever. The working barrel is bored truly cylindrical, and the piſton is made of metal of a ſize that will juſt paſs along it without ſticking. When this is drawn up with the velocity competent to a properly loaded machine, the quantity of water which eſcapes round the piſton is inſignificant. The piſton is made without leathers, not to avoid friction, which is alſo inſignificant in ſuch works; but to avoid the neceſſity of frequently drawing it up for repairs through ſuch a length of pipes.

45 Example of a ſimple pump without friction.

V. If a pump abſolutely without friction is wanted, the following ſeems preferable for ſimplicity and performance to any we have ſeen, when made uſe of in proper ſituations. Let NO (fig. 18.) be the ſurface of the water in the pit, and K the place of delivery. The pit muſt be as deep in water as from K to NO. ABCD is a wooden trunk, round or ſquare, open at both ends, and having a valve P at the bottom. The top of this trunk muſt be on a level with K, and has a ſmall ciſtern EADF. It alſo communicates laterally with a riſing pipe GHK, furniſhed with a valve at H opening upwards. LM is a beam of timber ſo fitted to the trunk as to fill it without ſticking, and is of at leaſt equal length. It hangs by a chain from a working beam, and is loaded on the top with weights exceeding that of the column of water which it diſplaces. Now ſuppoſe this beam allowed to deſcend from the poſition in which it is drawn in the figure; the water muſt riſe all around it, in the crevice which is between it and the trunk, and alſo in the riſing pipe; becauſe the valve P ſhuts, and H opens; ſo that when the plunger has got to the bottom, the water will ſtand at the level of K. When the plunger is again drawn up to the top by the action of the moving power, the water ſinks again in the trunk, but not in the riſing pipe, becauſe it is ſtopped by the valve H. Then allowing the plunger to deſcend again, the water muſt again riſe in the trunk to the level of K, and it muſt now flow out at K; and the quantity diſcharged will be equal to the part of the beam below the ſurface of the pit-water, deducting the quantity which fills the ſmall ſpace between the beam and the trunk. This quantity may be reduced almoſt to nothing; for if the inſide of the trunk and the outſide of the beam be made tapering, the beam may be let down till they exactly fit; and as this may be done in ſquare work, a good workman can make it exceedingly accurate. But in this caſe, the lower half of the beam and trunk muſt not taper; and this part of the trunk muſt be of ſufficient width round the beam to allow free paſſage into the riſing pipe. Or, which is better, the riſing pipe muſt branch off from the bottom of the trunk. A diſcharge may be made from the ciſtern EADF, ſo that as little water as poſſible may deſcend along the trunk when the piſton is raiſed.

46 Its excellencies are conſiderable,

One great excellence of this pump is, that it is perfectly free from all the deficiencies which in common pumps reſult from want of being air-tight. Another is, that the quantity of water raiſed is preciſely equal to the power expended; for any want of accuracy in the work, while it occaſions a diminution of the quantity of water diſcharged, makes an equal diminution in the weight which is neceſſary for puſhing down the plunger. We have ſeen a machine conſiſting of two ſuch pumps ſuſpended from the arms of a long beam, the upper ſide of which was formed into a walk with a rail on each ſide. A man ſtood on one end till it got to the bottom, and then walked ſoberly up to the other end, the inclination being about twenty-five degrees at firſt, but gradually diminiſhed as he went along, and changed the load of the beam. By this means he made the other end go to the bottom, and ſo on alternately, with the eaſieſt of all exertions, and what we are moſt fitted for by our ſtructure. With this machine, a very feeble old man, weighing 110 pounds, raiſed 7 cubic feet of water $11\frac{1}{2}$ feet high in a minute, and continued working 8 or 10 hours every day. A ſtout young man, weighing nearly 135 pounds, raiſed $8\frac{1}{3}$ to the ſame height; and when he carried 30 pounds, conveniently ſlung about him, he raiſed $9\frac{1}{4}$ feet to this height, working 10 hours a-day without fatiguing himſelf. This exceeds Deſaguliers's maximum of a hogſhead of water 10 feet high in a minute, in the pro-

Pump.

portion of 9 to 7 nearly. It is limited to very moderate heights; but in such situations it is very effectual. It was the contrivance of an untaught labouring man, possessed of uncommon mechanical genius. We shall have occasion to mention, with respect, some other contrivances of the same person in the article *Water-Works*.

47 But it is limited.

48 Haskin's pump described.

VI. The most ingenious contrivance of a pump without friction is that of Mr Haskins, described by Desaguliers, and called by him the Quicksilver Pump. Its construction and mode of operation are pretty complicated; but the following preliminary observations will, we hope, render it abundantly plain.

Let *i l m k* (fig. 19.) be a cylindrical iron pipe, about six feet long, open at top. Let *e g h f* be another cylinder, connected with it at the bottom, and of smaller diameter. It may either be solid, or, if hollow, it must be close at top. Let *a c d b* be a third iron cylinder, of an intermediate diameter, so that it may move up and down between the other two without touching either, but with as little interval as possible. Let this middle cylinder communicate by means of the pipe AB, with the upright pipe FE, having valves C and D (both opening upwards) adjoining to the pipe of communication. Suppose the outer cylinder suspended by chains from the end of a working beam, and let mercury be poured into the interval between the three cylinders till it fills the space to *o p*, about $\frac{1}{4}$ of their height. Also suppose that the lower end of the pipe FE is immersed into a cistern of water, and that the valve D is less than 33 feet above the surface of this water.

49 Its mode of operation.

Now suppose a perforation made somewhere in the pipe AB, and a communication made with an air-pump. When the air-pump is worked, the air contained in CE, in AB, and in the space between the inner and middle cylinders, is rarefied, and is abstracted by the air-pump; for the valve D immediately shuts. The pressure of the atmosphere will cause the water to rise in the pipe CE, and will cause the mercury to rise between the inner and middle cylinders, and sink between the outer and middle cylinders. Let us suppose mercury 12 times heavier than water: Then for every foot that the water rises in EC, the level between the outside and inside mercury will vary an inch; and if we suppose DE to be 30 feet, then if we can rarefy the air so as to raise the water to D, the outside mercury will be depressed to *q*, *r*, and the inside mercury will have risen to *s*, *t*, *s q* and *t r* being about 30 inches. In this state of things, the water will run over by the pipe BA, and every thing will remain nearly in this position. The columns of water and mercury balance each other, and balance the pressure of the atmosphere.

While things are in this state of equilibrium, if we allow the cylinders to descend a little, the water will rise in the pipe FE, which we may now consider as a suction-pipe; for by this motion the capacity of the whole is enlarged, and therefore the pressure of the atmosphere will still keep it full, and the situation of the mercury will again be such that all shall be in equilibrio. It will be a little lower in the inside space and higher in the outside.

Taking this view of things, we see clearly how the water is supported by the atmosphere at a very considerable height. The apparatus is analogous to a syphon which has one leg filled with water and the other with mercury. But it was not necessary to employ an air-pump to fill it. Suppose it again empty, and all the valves shut by their own weight. Let the cylinders descend a little. The capacity of the spaces below the valve D is enlarged, and therefore the included air is rarefied, and some of the air in the pipe CE must diffuse itself into the space quitted by the inner cylinder. Therefore the atmosphere will press some water up the pipe FE, and some mercury into the inner space between the cylinders. When the cylinders are raised again, the air which came from the pipe CE would return into it again, but is prevented by the valve C.—Raising the cylinders to their former height would compress this air; it therefore lifts the valve D, and escapes. Another depression of the cylinders will have a similar effect. The water will rise higher in FC, and the mercury in the inner space; and then, after repeated strokes, the water will pass the valve C, and fill the whole apparatus, as the air-pump had caused it to do before.—The position of the cylinders, when things are in this situation, is represented in fig. 20, the outer and inner cylinders in their lowest position having descended about 30 inches. The mercury in the outer space stands at *q*, *r*, a little above the middle of the cylinders, and the mercury in the inner space is near the top *t s* of the inner cylinder. Now let the cylinders be drawn up. The water above the mercury cannot get back again through the valve C, which shuts by its own weight. We therefore attempt to compress it; but the mercury yields, and descends in the inner space, and rises in the outer till both are quickly on a level, about the height *v v*. If we continue to raise the cylinders, the compression forces out more mercury, and it now stands lower in the inner than in the outer space. But that there may be something to balance this inequality of the mercurial columns, the water goes through the valve D, and the equilibrium is restored when the height of the water in the pipe ED above the surface of the internal mercury is 12 times the difference of the mercurial columns (on the former supposition of specific gravity.) If the quantity of water is such as to rise two feet in the pipe ED, the mercury in the outer space will be two inches higher than that in the inner space. Another depression of the cylinders will again enlarge the space within the apparatus, the mercury will take the position of fig. 19. and more water will come in. Raising the cylinders will send this water four feet up the pipe ED, and the mercury will be four inches higher in the inner than in the outer space. Repeating this operation, the water will be raised still higher in DE; and this will go on till the mercury in the outer space reaches the top of the cylinder; and this is the limit of the performance. The dimensions with which we set out will enable the machine to raise the water about 30 feet in the pipe ED; which, added to the 30 feet of CF, makes the whole height above the pit-water 60 feet. By making the cylinders longer, we increase the height of FD. This machine must be worked with great attention, and but slowly; for at the beginning of the forcing stroke the mercury very rapidly sinks in the inner space and rises in the outer, and will dash out and be lost. To pre-

Pump.

vent this as much as poſſible, the outer cylinder terminates in a ſort of cup or diſh, and the inner cylinder ſhould be tapered atop.

50 Ingenuity of the contrivance great,

The machine is exceedingly ingenious and refined; and there is no doubt but that its performance will exceed that of any other pump which raiſes the water to the ſame height, becauſe friction is completely avoided, and there can be no want of tightneſs of the piſton.—

51 But the advantage trifling.

But this is all its advantage; and, from what has been obſerved, it is but trifling. The expence would be enormous; for with whatever care the cylinders are made, the interval between the inner and outer cylinders muſt contain a very great quantity of mercury. The middle cylinder muſt be made of iron plate, and muſt be without a ſeam, for the mercury would diſſolve every ſolder. For ſuch reaſons, it has never come into general uſe. But it would have been unpardonable to have omitted the deſcription of an invention which is ſo original and ingenious; and there are ſome occaſions where it may be of great uſe, as in nice experiments for illuſtrating the theory of hydraulics, it would give the fineſt piſtons for meaſuring the preſſures of water in pipes, &c. It is on preciſely the ſame principle that the cylinder bellows, deſcribed in the article PNEUMATICS, are conſtructed.

52 Deſcription of another pump without friction.

We beg leave to conclude this part of the ſubject with the deſcription of a pump without friction, which may be conſtructed in a variety of ways by any common carpenter, without the aſſiſtance of the pump-maker or plumber, and will be very effective for raiſing a great quantity of water to ſmall heights, as in draining marſhes, marle pits, quarries, &c. or even for the ſervice of a houſe.

VII. ABCD (fig. 21.) is a ſquare trunk of carpenter's work open at both ends, and having a little ciſtern and ſpout at top. Near the bottom there is a partition made of board, perforated with a hole E, and covered with a clack. *ffff* repreſents a long cylindrical bag or pudding, made of leather or of double canvas, with a fold of thin leather ſuch as ſheepſkin between the canvas bags. This is firmly nailed to the board E with ſoft leather between. The upper end of this bag is fixed on a round board, having a hole and valve F. This board may be turned in the lathe with a groove round its edge, and the bag faſtened to it by a cord bound tight round it. The fork of the piſton-rod FG is firmly fixed into this board; the bag is kept diſtended by a number of wooden hoops or rings of ſtrong wire *ff*, *ff*, *ff*, &c. put into it at a few inches diſtance from each other. It will be proper to connect theſe hoops before putting them in, by three or four cords from top to bottom, which will keep them at their proper diſtances. Thus will the bag have the form of a barber's bellows powder-puff. The diſtance between the hoops ſhould be about twice the breadth of the rim of the wooden ring to which the upper valve and piſton-rod are fixed.

53 Its mode of operation, &c.

Now let this trunk be immerſed in the water. It is evident that if the bag be ſtretched from the compreſſed form which its own weight will give it by drawing up the piſton-rod, its capacity will be enlarged, the valve F will be ſhut by its own weight, the air in the bag will be rarefied, and the atmoſphere will preſs the water into the bag. When the rod is thruſt down again, this water will come out by the valve F, and fill part of the trunk. A repetition of the operation will have a ſimilar effect; the trunk will be filled, and the water will at laſt be diſcharged by the ſpout. Pump.

Here is a pump without friction, and perfectly tight. For the leather between the folds of canvas renders the bag impervious both to air and water. And the canvas has very conſiderable ſtrength. We know from experience that a bag of ſix inches diameter, made of ſail-cloth n°3. with a ſheep ſkin between, will bear a column of 15 feet of water, and ſtand ſix hours work *per* day for a month without failure, and that the pump is conſiderably ſuperior in effect to a common pump of the ſame dimenſions. We muſt only obſerve, that the length of the bag muſt be three times the intended length of the ſtroke; ſo that when the piſton-rod is in its higheſt poſition, the angles or ridges of the bag may be pretty acute. If the bag be more ſtretched than this, the force which muſt be exerted by the labourer becomes much greater than the weight of the column of water which he is raiſing. If the pump be laid aſlope, which is very uſual in theſe occaſional and haſty drawings, it is neceſſary to make a guide for the piſton-rod within the trunk, that the bag may play up and down without rubbing on the ſides, which would quickly wear it out.

The experienced reader will ſee that this pump is very like that of Goſſet and De la Deuille, deſcribed by Belidor Vol. II. p. 120. and moſt writers on hydraulics. It would be ſtill more like it, if the bag were on the under ſide of the partition E, and a valve placed farther down the trunk. But we think that our form is greatly preferable in point of ſtrength. When in the other ſituation, the column of water lifted by the piſton tends to *burſt* the bag, and this with a great force, as the intelligent reader well knows. But in the form recommended here, the bag is *compreſſed*, and the ſtrain on each part may be made much leſs than that which tends to burſt a bag of ſix inches diameter. The nearer the rings are placed to each other the ſmaller will the ſtrain be.

The ſame bag-piſton may be employed for a forcing pump, by placing it below the partition, and inverting the valve; and it will then be equally ſtrong, becauſe the reſiſtance in this caſe too will act by compreſſion.

We now come naturally to the conſideration of the different forms which may be given to the piſtons and valves of a pump. A good deal of what we have been deſcribing already is reducible to this head; but, having a more general appearance, changing as it were the whole form and ſtructure of the pump, it was not improper to keep theſe things together.

54 Piſtons ſhould have little friction.

The great deſideratum in a piſton is, that it be as tight as poſſible, and have as little friction as is conſiſtent with this indiſpenſable quality. We have already ſaid, that the common form, when carefully executed, has theſe properties in an eminent degree. And accordingly this form has kept its ground amidſt all the improvements which ingenious artiſts have made. Mr Belidor, an author of the firſt reputation, has given the deſcription of a piſton which he highly extols, and is undoubtedly a very good one, conſtructed from principle, and extremely well compoſed.

55 An improved one by Belidor.

It conſiſts of a hollow cylinder of metal *g h* (fig. 22.) pierced with a number of holes, and having at top a flanch AB, whoſe diameter is nearly equal to that of the

Pump. the working-barrel of the pump. This flanch has a groove round it. There is another flanch IK below, by which this hollow cylinder is fastened with bolts to the lower end of the piston, represented in fig. 23. This consists of a plate CD, with a grooved edge similar to AB, and an intermediate plate which forms the seat of the valve. The composition of this part is better understood by inspecting the figure than by any description. The piston-rod HL is fixed to the upper plate by bolts through its different branches at G, G. This metal body is then covered with a cylindrical bag of leather, fastened on it by cords bound round it, filling up the grooves in the upper and lower plates. The operation of the piston is as follows.

A little water is poured into the pump, which gets past the sides of the piston, and lodges below in the fixed valve. The piston being pushed down dips into this water, and it gets into it by the valve. But as the piston in descending compresses the air below it, this compressed air also gets into the inside of the piston, swells out the bag which surrounds it, and compresses it to the sides of the working-barrel. When the piston is drawn up again, it must remain tight, because the valve will shut and keep in the air in its most compressed state; therefore the piston must perform well during the suction. It must act equally well when pushed down again, and acting as a forcer; for however great the resistance may be, it will affect the air within the piston to the same degree, and keep the leather close applied to the barrel. There can be no doubt therefore of the piston's performing both its offices completely; but we imagine that the adhesion to the barrel will be greater than is necessary: it will extend over the whole surface of the piston, and be equally great in every part of its surface; and we suspect that the friction will therefore be very great. We have very high authority for supposing that the adhesion of a piston of the common form, carefully made, will be such as will make it perfectly tight; and it is evident that the adhesion of Belidor's piston will be much greater, and it will be productive of worse consequences. If the leather bag is worn through in any one place, the air escapes, and the piston ceases to be compressed altogether; whereas in the common piston there will very little harm result from the leather being worn through in one place, especially if it project a good way beyond the base of the cone. We still think the common piston preferable. Belidor's piston would do much better inverted as the piston of a sucking pump; and in this situation it would be equal, but not superior, to the common.

56 Its defects.

57 Another by the same author. Belidor describes another forcing piston, which he had executed with success, and prefers to the common wooden forcer. It consists of a metal cylinder or cone, having a broad flanch united to it at one end, and a similar flanch which is screwed on the other end. Between these two plates are a number of rings of leather strongly compressed by the two flanches, and then turned in a lathe like a block of wood, till the whole fits tight, when dry, into the barrel. It will swell, says he, and soften with the water, and withstand the greatest pressures. We cannot help thinking this but an indifferent piston. When it wears, there is nothing to squeeze it to the barrel. It may indeed be taken out and another ring or two of leather put in, or the flanches may be more strongly screwed together: but all this

58 Objections to it.

Pump. may be done with any kind of piston; and this has therefore no peculiar merit.

59 Another recommended as preferable. The following will, we presume, appear vastly preferable. ABCD (fig. 24.) is the solid wooden or metal block of the piston; EF is a metal plate, which is turned hollow or dish-like below, so as to receive within it the solid block. The piston rod goes through the whole, and has a shoulder above the plate EF, and a nut H below. Four screw-bolts, such as *i k*, *l m*, also go through the whole, having their heads *k*, *m* sunk into the block, and nuts above at *i*, *l*. The packing or stuffing, as it is termed by the workmen, is represented at NO. This is made as solid as possible, and generally consists of soft hempen twine well soaked in a mixture of oil, tallow, and rosin. The plate EF is gently screwed down, and the whole is then put into the barrel, fitting it as tight as may be thought proper. When it wears loose, it may be tightened at any time by screwing down the nuts *i l*, which cause the edges of the dish to squeeze out the packing, and compress it against the barrel to any degree.

60 Difficulties in constructing pistons. The greatest difficulty in the construction of a piston is to give a sufficient passage through it for the water, and yet allow a firm support for the valve, and fixture for the piston rod. We shall see presently that it occasions a considerable expence of the moving power to force a piston with a narrow perforation through the water lodged in the working barrel. When we are raising water to a small height, such as 10 or 20 feet, the power so expended amounts to a fourth part of the whole, if the water-way in the piston is less than one-half of the section of the barrel, and the velocity of the piston two feet *per* second, which is very moderate. There can be no doubt, therefore, that metal pistons are preferable, because their greater strength allows much wider apertures.

61 Considerably removed in one described by Belidor. The following piston, described and recommended by Belidor, seems as perfect in these respects as the nature of things will allow. We shall therefore describe it in the author's own words as a model, which may be adopted with confidence in the greatest works.

Plate CCCCXXVI. "The body of the piston is a truncated metal cone CCXX (fig. 25.), having a small fillet at the greater end. Fig. 26 shows the profile, and fig. 27. the plan of its upper base; where appears a cross bar DD, pierced with an oblong mortise E for receiving the tail of the piston-rod. A band of thick and uniform leather AA (fig. 26. and 28.) is put round this cone, and secured by a brass hoop BB firmly driven on its smaller end, where it is previously made thinner to give room for the hoop.

"This piston is covered with a leather valve, fortified with metal plates GG (fig. 29.) These plates are wider than the hole of the piston, so as to rest on its rim. There are similar plates below the leather of a smaller size, that they may go into the hollow of the piston; and the leather is firmly held between the metal plates by screws H, H, which go through all. This is represented by the dotted circle IK. Thus the pressure of the incumbent column of water is supported by the plates GG, whose circular edges rest on the brim of the water-way, and thus straight edges rest on the cross bar DD of fig. 26. and 27. This valve is laid on the top of the conical box in such a manner that its middle FF rests on the cross bar. To bind all together, the

Pump.

the end of the piſton-rod is formed like a croſs, and the arms MN (fig. 30.) are made to reſt on the diameter FF of the valve, the tail EP going through the hole E in the middle of the leather, and through the mortiſe E of the croſs bar of the box; and alſo through another bar QR (fig. 28. and 29.) which is notched into the lower brim of the box. A key V is then driven into the hole T in the piſton-rod; and this wedges all faſt. The bar QR is made ſtrong; and its extremities project a little, ſo as to ſupport the braſs hoop BB which binds the leather band to the piſton-box. The adjoining ſcale gives the dimenſions of all the parts, as they were executed for a ſteam-engine near Condé, where the piſton gave complete ſatisfaction."

62 Advantages of this piſton.

This piſton has every advantage of ſtrength, tightneſs, and large water-way. The form of the valve (which has given it the name of the *butterfly-valve*) is extremely favourable to the paſſage of the water; and as it has but half the motion of a complete circular valve, leſs water goes back while it is ſhutting.

63 Another ingenious and uſeful piſton deſcribed.

The following piſton is alſo ingenious, and has a good deal of merit. OPPO (fig. 31.) is the box of the piſton, having a perforation Q, covered above with a flat valve K, which reſts in a metal plate that forms the top of the box. ABCBA is a ſtirrup of iron to which the box is fixed by ſcrews *a*, *a*, *a*, *a*, whoſe heads are ſunk in the wood. This ſtirrup is perforated at C, to receive the end of the piſton-rod, and a nut H is ſcrewed on below to keep it faſt. DEFED is another ſtirrup, whoſe lower part at DD forms a hoop like the ſole of a ſtirrup, which embraces a ſmall part of the top of the wooden box. The lower end of the piſton-rod is ſcrewed; and before it is put into the holes of the two ſtirrups (through which holes it ſlides freely) a broad nut G is ſcrewed on it. It is then put into the holes, and the nut H firmly ſcrewed up. The packing RR is then wound about the piſton as tight as poſſible till it completely fills the working barrel of the pump. When long uſe has rendered it in any degree looſe, it may be tightened again by ſcrewing down the nut G. This cauſes the ring DD to compreſs the packing between it and the projecting ſhoulder of the box at PP; and thus cauſes it to ſwell out, and apply itſelf cloſely to the barrel.

64 Another on a different principle.

We ſhall add only another form of a perforated piſton; which being on a principle different from all the preceding, will ſuggeſt many others; each of which will have its peculiar advantages. OO in fig. 32. repreſents the box of this piſton, fitted to the working barrel in any of the preceding ways as may be thought beſt. AB is a croſs bar of four arms, which is fixed to the top of the box. CF is the piſton-rod going through a hole in the middle of AB, and reaching a little way beyond the bottom of the box. It has a ſhoulder D, which prevents its going too far through. On the lower end there is a thick metal plate, turned conical on its upper ſide, ſo as to fit a conical ſeat PP in the bottom of the piſton-box.

When the piſton-rod is puſhed down, the friction on the barrel prevents the box from immediately yielding. The rod therefore ſlips through the hole of the croſs bar AB. The plate E, therefore, detaches itſelf from the box. When the ſhoulder D preſſes on the bar AB, the box muſt yield, and be puſhed down the barrels, and the water gets up through the perforation. When the piſton-rod is drawn up again, the box does not move till the plate E lodged in the ſeat PP, and thus ſhuts the water-way; and then the piſton lifts the water which is above it, and acts as the piſton of a ſucking pump.

Pump.

65 Its advantages.

This is a very ſimple and effective conſtruction, and makes a very tight valve. It has been much recommended by engineers of the firſt reputation, and is frequently uſed; and from its ſimplicity, and the great ſolidity of which it is capable, it ſeems very fit for great works. But it is evident that the water-way is limited to leſs than one-half of the area of the working-barrel. For if the perforation of the piſton be one-half of the area, the diameter of the plate or ball EF muſt be greater; and therefore leſs than half the area will be left for the paſſage of the water by its ſides.

66 Obſervations on valves.

We come now to conſider the forms which may be given to the valves of a hydraulic engine.

The requiſites of a valve are, that it ſhall be tight, of ſufficient ſtrength to reſiſt the great preſſures to which it is expoſed, that it afford a ſufficient paſſage for the water, and that it do not allow much to go back while it is ſhutting.

67 Clack valves.

We have not much to add to what has been ſaid already on this ſubject. The valves which accompany the pump of fig. 5. are called *clack valves*, and are of all the moſt obvious and common; and the conſtruction deſcribed on that occaſion is as perfect as any. We only add, that as the leather is at laſt deſtroyed at the hinge by ſuch inceſſant motion, and it is troubleſome, eſpecially in deep mines, and under water, to undo the joint of the pump in order to put in a new valve, it is frequently annexed to a box like that of a piſton, made a little conical on the outſide, ſo as to fit a conical ſeat made for it in the pipe, as repreſented in fig. 33. and it has an iron handle like that of a baſket, by which it can be laid hold of by means of a long grappling-hook let down from above. Thus it is drawn up; and being very gently tapered on the ſides, it ſticks very faſt in its place.

68 Defect in them.

The only defect of this valve is, that by opening very wide when puſhed up by the ſtream of water, it allows a good deal to go back during its ſhutting again. In ſome great machines which are worked by a ſlow turning crank, the return of the piſton is ſo very ſlow, that a ſenſible loſs is incurred by this; but it is nothing like what Dr Deſaguliers ſays, one-half of a cylinder whoſe height is equal to the diameter of the valve.—For in ſuch machines, the laſt part of the upward ſtroke is equally ſlow, and the velocity of the water through the valve exceedingly ſmall, ſo that the valve is at this time almoſt ſhut.

69 Utility of the butterfly-valves.

The butterfly-valve repreſented in figures 29, &c. is free from moſt of thoſe inconveniences, and ſeems the moſt perfect of the clack valves. Some engineers make their great valves of a pyramidal form, conſiſting of four clacks, whoſe hinges are in the circumference of the water-way, and which meets with their points in the middle, and are ſupported by four ribs which riſe up from the ſides, and unite in the middle. This is an excellent form, affording the moſt ſpacious water-way, and ſhutting very readily. It ſeems to be the beſt poſſible for a piſton. The rod of the piſton is branched out on four ſides, and the branches go through the piſton-box, and are faſtened below with ſcrews. Theſe branches

Pump. branches form the ſupport for the four clacks. We have ſeen a valve of this form in a pump of ſix feet diameter, which diſcharged 20 hogſheads of water every ſtroke, and made 12 ſtrokes in a minute, raiſing the water above 22 feet.

70 Button valves

There is another form of valve, called the *button* or *tail valve*. It conſiſts of a plate of metal AB (fig. 34.) turned conical, ſo as exactly to fit the conical cavity *a b* of its box. A tail CD projects from the under ſide, which paſſes through a croſs bar EF in the bottom of the box, and has a little knob at the end, to hinder the valve from riſing too high.

71 Very uſeful;

This valve, when nicely made, is unexceptionable. It has great ſtrength, and is therefore proper for all ſevere ſtrains, and it may be made perfectly tight by grinding. Accordingly it is uſed in all caſes where this is of indiſpenſable conſequence. It is moſt durable, and the only kind that will do for paſſages where ſteam or hot water is to go through. Its only imperfection is a ſmall water-way; which, from what has been ſaid, cannot exceed, nor indeed equal, one-half of the area of the pipe.

72 Though ſomewhat imperfect in the water-way.

If we endeavour to enlarge the water-way, by giving the cone very little taper, the valve frequently ſticks ſo faſt in the ſeat that no force can detach them.—And this ſometimes happens during the working of the machine; and the jolts and blows given to the machine in taking it to pieces, in order to diſcover what has been the reaſon that it has diſcharged no water, frequently detaches the valve, and we find it quite looſe, and cannot tell what has deranged the pump. When this is guarded againſt, and the diminution of the water-way is not of very great conſequence, this is the beſt form of a valve.

73 A very ſimple valve deſcribed.

Analogous to this is the ſimpleſt of all valves, repreſented in fig. 35. It is nothing more than a ſphere of metal A, to which is fitted a ſeat with a ſmall portion BC of a ſpherical cavity. Nothing can be more effectual than this valve; it always falls into its proper place, and in every poſition fits it exactly. Its only imperfection is the great diminution of the water-way. If the diameter of the ſphere does not conſiderably exceed that of the hole, the touching parts have very little taper, and it is very apt to ſtick faſt. It oppoſes much leſs reſiſtance to the paſſage of the water than the flat under-ſurface of the button-valve. *N. B.* It would be an improvement of that valve to give it a taper-ſhape below like a boy's top. The ſpherical valve muſt not be made too light, otherwiſe it will be hurried up by the water, and much may go back while it is returning to its place.

74 A valve by Belidor uniting every requiſite.

Belidor deſcribes with great minuteneſs (vol. ii. p. 221, &c.) a valve which unites every requiſite. But it is of ſuch nice and delicate conſtruction, and its defects are ſo great when this exactneſs is not attained, or is impaired by uſe, that we think it hazardous to introduce it into a machine in a ſituation where an intelligent and accurate artiſt is not at hand. For this reaſon we have omitted the deſcription, which cannot be given in few words, nor without many figures; and deſire our curious readers to conſult that author, or peruſe Dr Deſagulier's tranſlation of this paſſage. Its principle is preciſely the ſame with the following rude contrivance, with which we ſhall conclude the deſcriptive part of this article.

Suppoſe ABCD (fig. 36.) to be a ſquare wooden trunk. EF is a piece of oak-board, exactly fitted to the trunk in an oblique poſition, and ſupported by an iron pin which goes through it at I, one-third of its length from its lower extremity E. The two ends of this board are bevelled, ſo as to apply exactly to the ſides of the trunk. It is evident, that if a ſtream of water comes in the direction BA, its preſſure on the part IF of this board will be greater than that upon EI. It will therefore force it up and ruſh through, making it ſtand almoſt parallel to the ſides of the trunk. To prevent its riſing ſo far, a pin muſt be put in its way. When this current of water changes its direction, the preſſure on the upper ſide of the board being again greateſt on the portion IF, it is forced back again to its former ſituation; and its two extremities reſting on the oppoſite ſides of the trunk, the paſſage is completely ſtopped. This board therefore performs the office of a valve; and this valve is the moſt perfect that can be, becauſe it offers the freeſt paſſage to the water, and it allows very little to get back while it is ſhutting; for the part IE brings up half as much water as IF allows to go down. It may be made extremely tight, by fixing two thin fillets H and G to the ſides of the trunk, and covering thoſe parts of the board with leather which applies to them; and in this ſtate it perfectly reſembles Belidor's fine valve. Pump. 75 Another valve on the ſame principle.

76 Deſcription of an occaſional pump eaſily conſtructed.

And this conſtruction of the valve ſuggeſts, by the way, a form of an occaſional pump, which may be quickly ſet up by any common carpenter, and will be very effectual in ſmall heights. Let *a b c d e* (fig. 36.) be a ſquare box made to ſlide along this wooden trunk without ſhake, having two of its ſides projecting upwards, terminating like the gable-ends of a houſe. A piece of wood *e* is mortiſed into theſe two ſides, and to this the piſton-rod is fixed. This box being furniſhed with a valve ſimilar to the one below, will perform the office of a piſton. If this pump be immerſed ſo deep in the water that the piſton ſhall alſo be under water, we ſcruple not to ſay that its performance will be equal to any. The piſton may be made abundantly tight by covering its outſide neatly with ſoft leather. And as no pipe can be bored with greater accuracy than a very ordinary workman can make a ſquare trunk, we preſume that this pump will not be very deficient even for a conſiderable ſuction.

77 The motion of water in pumps

We now proceed to the laſt part of the ſubject, to conſider the motion of water in pumps, in reference to the force which muſt be employed. What we have hitherto ſaid with reſpect to the force which muſt be applied to a piſton, related only to the ſuſtaining the water at a certain height: but in actual ſervice we muſt not only do this, but we muſt diſcharge it at the place of delivery in a certain quantity; and this muſt require a force ſuperadded to what is neceſſary for its mere ſupport at this height.

78 An intricate ſubject.

This is an extremely intricate and difficult ſubject, and very imperfectly underſtood even by profeſſed engineers. The principles on which this knowledge muſt be founded are of a much more abſtruſe nature than the ordinary laws of hydroſtatics; and all the genius of Newton was employed in laying the foundation of this part of phyſical ſcience. It has been much cultivated in the courſe of this century by the firſt mathematicians of Europe. Daniel and John Bernoulli have written very

Pump.

very elaborate treatiſes on the ſubject, under the very appoſite name of HYDRODYNAMICS; in which, although they have added little or nothing to the fundamental propoſitions eſtabliſhed in ſome ſort by Newton, and acquieſced in by them, yet they have greatly contributed to our progreſs in it by the *methods* which they have purſued in making application of thoſe fundamental propoſitions to the moſt important caſes. It muſt be acknowledged, however, that both theſe propoſitions, and the extenſions given them by theſe authors, are ſupported by a train of argument that is by no means unexceptionable; and that they proceed on aſſumptions or poſtulates which are but nearly true in any caſe, and in many are inadmiſſible: and it remains to this hour a wonder or puzzle how theſe propoſitions and their reſults correſpond with the phenomena which we obſerve.

*79 The theory denominated *Hydrodynamics*,

But fortunately this correſpondence does obtain to a certain extent. And it ſeems to be this correſpondence chiefly which has given theſe authors, with Newton at their head, the conſiſtence which they place in their reſpective principles and methods: for there are conſiderable differences among them in thoſe reſpects; and each ſeems convinced that the others are in a miſtake. Meſſieurs d'Alembert and De la Grange have greatly corrected the theories of their predeceſſors, and have proceeded on poſtulates which come much nearer to the real ſtate of the caſe. But their inveſtigations involve us in ſuch an inextricable maze of analytical inveſtigation, that even when we are again conducted to the light of day by the clue which they have given us, we can make no uſe of what we there diſcovered.

80 Though imperfect is very uſeful.

But this theory, imperfect as it is, is of great ſervice. It generalizes our obſervations and experiments, and enables us to compoſe a *practical doctrine* from a heap of facts which otherwiſe muſt have remained ſolitary and unconnected, and as cumberſome in their application as the characters of the Chineſe writing.

81 Fundamental propoſition.

The fundamental propoſition of this practical hydrodynamics is, that water or any fluid contained in an open veſſel of indefinite magnitude, and impelled by its weight only, will flow through a ſmall orifice with the velocity which a heavy body would acquire by falling from the horizontal ſurface of the fluid. Thus, if the orifice is 16 feet under the ſurface of the water, it will iſſue with the velocity of 32 feet in a ſecond.

Its velocity correſponding to any other depth h of the orifice under the ſurface, will be had by this eaſy proportion: "As the ſquare root of 16 is to the ſquare root of h; ſo is 32 feet to the velocity required: or, alternately, $\sqrt{16} : 32 = \sqrt{h} : v$, and $v = \frac{32\sqrt{h}}{\sqrt{16}} = \frac{32}{4}\sqrt{h}, = 8\sqrt{h}$: that is, multiply the ſquare root of the height in feet by eight, and the product is the required velocity.

On the other hand, it frequently occurs, that we want to diſcover the depth under the ſurface which will produce a known velocity v. Therefore $\sqrt{h} = \frac{v}{8}$, and $h = \frac{v^2}{64}$: that is, divide the ſquare of the velocity by 64, and the quotient is the depth wanted in feet.

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This propoſition is ſufficient for all our purpoſes. For ſince water is nearly a perfect fluid, and propagates all impreſſions undiminiſhed, we can, in place of any preſſure of a piſton or other cauſe, ſubſtitute a perpendicular column of water whoſe weight is equal to this preſſure, and will therefore produce the ſame efflux.—Thus, if the ſurface of a piſton is half a ſquare foot, and it be preſſed down with the weight of 500 pounds, and we would wiſh to know with what velocity it would cauſe the water to flow through a ſmall hole, we know that a column of water of this weight, and of half a foot baſe, would be 16 feet high. And this propoſition teaches us, that a veſſel of this depth will have a velocity of efflux equal to 32 feet in a ſecond.

82 Its utility

If therefore our preſſing power be of ſuch a kind that it can continue to preſs forward the piſton with the force of 500 pounds, the water will flow with this velocity, whatever be the ſize of the hole. All that remains is, to determine what change of *actual preſſure* on the piſton reſults from the motion of the piſton itſelf, and to change the velocity of efflux in the ſubduplicate ratio of the change of actual preſſure.

83 Remark previous to its application.

But before we can apply this knowledge to the circumſtances which take place in the motion of water in pumps, we muſt take notice of an important modification of the fundamental propoſition, which is but very obſcurely pointed out by any good theory, but is eſtabliſhed on the moſt regular and unexceptionable obſervation.

If the efflux is made through a hole in a thin plate, and the velocity is computed as above, we ſhall diſcover the quantity of water which iſſues in a ſecond by obſerving, that it is a priſm or cylinder of the length indicated by the velocity, and having its tranſverſe ſection equal to that of the orifice. Thus, in the example already given, ſuppoſing the hole to be a ſquare inch, the ſolid contents of this priſm, or the quantity of water iſſuing in a ſecond, is $1 \times 32 \times 12$ cubic inches, or 384 cubic inches. This we can eaſily meaſure by receiving it in a veſſel of known dimenſions. Taking this method, we uniformly find a deficiency of nearly 38 parts in 100; that is, if we ſhould obtain 100 gallons in any number of ſeconds, we ſhall in fact get only 62. This is a moſt regular fact, whether the velocities are great or ſmall, and whatever be the ſize and form of the orifice. The deficiency increaſes indeed in a very minute degree with the velocities. If, for inſtance, the depth of the orifice be one foot, the diſcharge is $\frac{6213}{10000}$; if it be 15 feet, the diſcharge is $\frac{6172}{10000}$.

This deficiency is not owing to a diminution of velocity; for the velocity may be eaſily and accurately meaſured by the diſtance to which the jet will go, if directed horizontally. This is found to correſpond very nearly with the propoſition, making a very ſmall allowance for friction at the border of the hole, and for the reſiſtance of the air. Sir Iſaac Newton aſcribed the deficiency with great juſtice to this, that the lateral columns of water, ſurrounding the column which is incumbent on the orifice, preſs towards the orifice, and contribute to the expence equally with that column. Theſe lateral filaments, therefore, iſſue obliquely, croſsing the motion of the central ſtream, and produce a contraction of the jet; and the whole ſtream does not acquire a parallel motion and its ultimate velocity till it

Pump. has got to ſome diſtance from the orifice. Careful obſervation ſhowed him that this was really the caſe. But even his genius could not enable him to aſcertain the motion of the lateral filaments by theory, and he was obliged to meaſure every thing as he ſaw it. He found the diameter of the jet at the place of the greateſt contraction to be preciſely ſuch as accounted for the deficiency. His explication has been unanimouſly acquieſced in; and experiments have been multiplied to aſcertain all thoſe circumſtances which our theory cannot determine *à priori*. The moſt complete ſet of experiments are thoſe of Michelotti, made at Turin at the expence of the prince of Piedmont. Here jets were made of 1, 2, 3, and 4 inches diameter; and the water received into ciſterns moſt accurately formed of brick, and lined with ſtucco. It is the reſult of theſe experiments which we have taken for a meaſure of the deficiency.

We may therefore conſider the water as flowing through a hole of this contracted dimenſion, or ſubſtitute this for the real orifice in all calculations. For it is evident that if a mouth-piece (ſo to call it) were made, whoſe internal ſhape preciſely tallied with the form which the jet aſſumes, and if this mouth-piece be applied to the orifice, the water will flow out without any obſtruction. The veſſel may therefore be conſidered as really having this mouth-piece.

Nay, from this we derive a very important obſervation, "that if, inſtead of allowing the water to flow through a hole of an inch area made in a thin plate, we make it flow through a hole in a thick plank, ſo formed that the external orifice ſhall have an inch area, but be widened internally agreeably to the ſhape which nature forms, both the velocity and quantity will be that which the fundamental propoſition determines. Michelotti meaſured with great care the form of the great jets of three and four inches diameter, and found that the bounding curve was an elongated trochoid. He then made a mouth-piece of this form for his jet of one inch, and another for his jet of two inches; and he found the diſcharges to be $\frac{979}{1000}$ and $\frac{987}{1000}$; and he, with juſtice, aſcribed the trifling deficiency which ſtill remained, partly to friction and partly to his not having exactly ſuited his mouth-piece to the natural form. We imagine that this laſt circumſtance was the ſole cauſe: For, in the firſt place, the water in his experiments, before getting at his jet-holes, had to paſs along a tube of eight inches diameter. Now a jet of four inches bears too great a proportion to this pipe; and its narrowneſs undoubtedly hindered the lateral columns from contributing to the efflux in their due proportion, and therefore rendered the jet leſs convergent. And, in the next place, there can be no doubt (and the obſervations of Daniel Bernoulli confirm it) but that this convergency begins within the veſſel, and perhaps at a very conſiderable diſtance from the orifice. And we imagine, that if accurate obſervations could be made on the motion of the remote lateral particles within the veſſel, and an internal mouth-piece were ſhaped according to the curve which is deſcribed by the remoteſt particle that we can obſerve, the efflux of water would almoſt perfectly tally with the theory. But indeed the coincidence is already ſufficiently near for giving us very valuable information. We learn that the quantity of water which flows through a hole, in conſequence of its own weight, or by the action of any force, may be increaſed one half by properly ſhaping the paſſage to this hole; for we ſee that it may be increaſed from 62 to near 99. Pump.

But there is another modification of the efflux, which we confeſs our total incapacity to explain. If the water iſſues through a hole made in a plate whoſe thickneſs is about twice the diameter of the hole, or, to expreſs it better, if it iſſues through a pipe whoſe length is about twice its diameter, the quantity diſcharged is nearly $\frac{82}{100}$ of what reſults from the propoſition. If the pipe be longer than this, the quantity is diminiſhed by friction, which increaſes as the length of the pipe increaſes. If the pipe be ſhorter, the water will not fill it, but detaches itſelf at the very entry of the pipe, and flows with a contracted jet. When the pipe is of this length, and the extremity is ſtopped with the finger, ſo that it begins to flow with a full mouth, no ſubſequent contraction is obſerved; but merely ſtriking on the pipe with a key or the knuckle is generally ſufficient to detach the water in an inſtant from the ſides of the pipe, and reduce the efflux to $\frac{62}{100}$.

This effect is moſt unaccountable. It certainly ariſes from the mutual adheſion or attraction between the water and the ſides of the pipe; but how this, acting at right angles to the motion, ſhould produce an increaſe from 62 to 82, nearly $\frac{1}{7}$, we cannot explain. It ſhows, however, the prodigious force of this attraction, which in the ſpace of two or three inches is able to communicate a great velocity to a very great body of water. Indeed the experiments on capillary tubes ſhow that the mutual attraction of the parts of water is ſome thouſands of time greater than their weight.

We have only further to add, that every increaſe of pipe beyond two diameters is accompanied with a diminution of the diſcharge; but in what ratio this is diminiſhed it is very difficult to determine. We ſhall only obſerve at preſent that the diminution is very great. A pipe of 2 inches diameter and 30 feet long has its diſcharge only $\frac{54}{100}$ of what it would be if only 4 inches long. If its length be 60 feet, its diſcharge will be no more than $\frac{39}{100}$. A pipe of 1 inch diameter would have a diſcharge of $\frac{44}{100}$, and $\frac{31}{100}$, in the ſame ſituation. Hence we may conclude that the diſcharge of a 4-inch pipe of 30 feet long will not exceed $\frac{1}{3}$ of what it would be if only 8 inches long. This will ſuffice for our preſent purpoſes; and the determination of the velocities and diſcharges in long conduits from pump-machines muſt be referred to the article *Water-Works*. At preſent we ſhall confine our attention to the pump itſelf, and to what will contribute to its improvement.

Before we can proceed to apply this fundamental propoſition to our purpoſe, we muſt anticipate in a looſe way a propoſition of continual uſe in the conſtruction of *Water-Works*.

Let water be ſuppoſed ſtagnant in a veſſel EFGH (fig. 37.), and let it be allowed to flow out by a cylindrical pipe HIKL, divided by any number of partitions B, C, D, &c. Whatever be the areas B, C, D, of theſe orifices, the velocity in the intermediate parts of the pipe will be the ſame; for as much paſſes through any one orifice in a ſecond as paſſes through any other in the ſame time, or through any ſection of the intervening pipe. Let this velocity in the pipe be V, and let the area of the pipe be A. The velocity in the ori-

Pump.

fices B, C, D, must be $\frac{VA}{B}$, $\frac{VA}{C}$, $\frac{VA}{D}$, &c. Let g be the velocity acquired in a second by a heavy body. Then, by the general propoſition, the height of water in the veſſel which will produce the velocity $\frac{VA}{B}$ in the firſt orifice alone, is $\frac{V^2A^2}{2gB^2}$. After this paſſage the velocity is again reduced to V in the middle of the ſpace between the firſt and ſecond orifices. In the ſecond orifice this velocity is changed to $\frac{VA}{C}$. This alone would have required a height of water $\frac{V^2A^2}{2gC^2}$. But the water is already moving with the velocity V, which would have reſulted from a height of water in veſſel (which we ſhall, in the language of the art, call the HEAD OF WATER) equal to $\frac{V^2}{2g}$. Therefore there is only required a head of water $\frac{V^2A^2}{2gC^2} - \frac{V^2}{2g}$, or $\frac{V^2}{2g} \times \overline{\frac{A^2}{C^2} - 1}$. Therefore the whole height neceſſary for producing the efflux through both orifices, ſo as ſtill to preſerve the velocity V in the intervening pipe, is $\frac{V^2}{2g} \times \overline{\frac{A^2}{B^2} + \frac{A^2}{C^2} - 1}$. In like manner the third orifice D would alone require a head of water $\frac{V^2}{2g} \times \overline{\frac{A^2}{D^2} - 1}$; and all the three would require a head $\frac{V^2}{2g} \times \overline{\frac{A^2}{B^2} + \frac{A^2}{C^2} + \frac{A^2}{D^2} - 2}$. By this induction may eaſily be ſeen what head is neceſſary for producing the efflux through any number of orifices.

Let the expence or quantity of water diſcharged in an unit of time (ſuppoſe a ſecond) be expreſſed by the ſymbol Q. This is meaſured by the product of the velocity by the area of the orifice, and is therefore $= VA$, or $\frac{VA}{B} \times B$, or $\frac{VA}{C} \times C$, &c. and $V = \frac{Q^2}{A^2}$. Therefore we may compute the head of water (which we ſhall expreſs by H) in reference to the quantity of water diſcharged, becauſe this is generally the intereſting circumſtance. In this view we have $H = \frac{Q^2}{2gA} \times \overline{\frac{A^2}{B^2} + \frac{A^2}{C^2} + \frac{A^2}{D^2} - 2}$: which ſhows that the head of water neceſſary for producing the diſcharge increaſes in the proportion of the ſquare of the quantity of water which is diſcharged.

84 To determine the motion of water, &c.

Theſe things being premiſed, it is an eaſy matter to determine the motion of water in a pump, and the quantity diſcharged, reſulting from the action of any force on the piſton, or the force which muſt be applied to the piſton in order to produce any required motion or quantity diſcharged. We have only to ſuppoſe that the force employed is the preſſure of a column of water of the diameter of the working barrel; and this is over and above the force which is neceſſary for merely ſupporting the water at the height of the place of delivery. The motion of the water will be the ſame in both caſes. Pump.

85 In the ſucking-pump.

Let us, firſt of all, conſider a ſucking-pump. The motion here depends on the preſſure of the air, and will be the ſame as if the pump were lying horizontally, and communicated with a reſervoir, in which is a head of water ſufficient to overcome all the obſtructions to the motion, and produce a velocity of efflux ſuch as we deſire. And here it muſt be noted that there is a limit. No velocity of the piſton can make the water riſe in the ſuction-pipe with a greater velocity than what would be produced by the preſſure of a column of water 33 feet high; that is, about 46 feet *per* ſecond.

Let the velocity of the piſton be V, and the area of the working barrel be A. Then, if the water fills the barrel as faſt as the piſton is drawn up, the diſcharge during the riſe of the piſton, or the number of cubic feet of water *per* ſecond, muſt be $= V \times A$. This is always ſuppoſed, and we have already aſcertained the circumſtances which enſure this to happen. If, therefore, the water arrived with perfect freedom to the piſton, the force neceſſary for giving it this velocity, or for diſcharging the quantity $V \times A$ in a ſecond, would be equal to the weight of the pillar of water whoſe height is $\frac{V^2}{2g}$, and baſe A.

It does not appear at firſt ſight that the force neceſſary for producing this diſcharge has any thing to do with the obſtructions to the aſcent of the water into the pump, becauſe this is produced by the preſſure of the atmoſphere, and it is the action of this preſſure which is meaſured by the head of water neceſſary for producing the internal motion in the pump. But we muſt always recollect that the piſton, before bringing up any water, and ſupporting it at a certain height, was preſſed on both ſides by the atmoſphere. While the air ſupports the column below the piſton, all the preſſure expended in this ſupport is abſtracted from its preſſure on the under part of the piſton, while its upper part ſtill ſupports the whole preſſure. The atmoſphere continues to preſs on the under ſurface of the piſton, through the intermedium of the water in the ſuction-pipe, with the difference of theſe two forces.—Now, while the piſton is drawn up with the velocity V, more of the atmoſpheric preſſure muſt be expended in cauſing the water to follow the piſton; and it is only with the remainder of its whole preſſure that it continues to preſs on the under ſurface of the piſton. Therefore, in order that the piſton may be raiſed with the velocity V, a force muſt be applied to it, over and above the force neceſſary for merely ſupporting the column of water, equal to that part of the atmoſpheric preſſure thus employed; that is, equal to the weight of the head of water neceſſary for forcing the water up through the ſuction-pipe, and producing the velocity V in the working barrel.

Therefore let B be the area of the mouth of the ſuction-pipe, and C the area of the fixed valve, and let the ſuction-pipe be of equal diameter with the working barrel. The head neceſſary for producing the velocity V on the working barrel is $\frac{V^2}{2g}\left(\frac{A^2}{B^2} + \frac{A^2}{C^2} - 1\right)$. If d expreſs the denſity of water; that is, if d be the

Pump. number of pounds in a cubic foot of water, then $dA\frac{V^2}{2g}$ will expreſs the weight of a column whoſe baſe is A, and height $\frac{V^2}{2g}$, all being reckoned in feet. Therefore the force which muſt be applied, when eſtimated in pounds, will be $p = \frac{dAV^2}{2g}\left(\frac{A^2}{B^2}+\frac{A^2}{C^2}-1.\right)$

The firſt general obſervation to be made on what has been ſaid is, that the power which muſt be employed to produce the neceſſary motion, in oppoſition to all the obſtacles, is in the proportion of the ſquare of the velocity which we would produce, or the ſquare of the quantity of water we would diſcharge.

We have hitherto proceeded on the ſuppoſition, that there is no contraction of the jet in paſſing through theſe two orifices. This we know would be very far from the truth. We muſt therefore accommodate things to theſe circumſtances, by diminiſhing B and C in the ratio of the contraction, and calling the diminiſhed areas b and c; then we have $p = \frac{AdV^2}{2g}\left(\frac{A^2}{b^2}+\frac{A^2}{c^2}-1\right)$.

What this diminution may be, depends on the form of the parts. If the fixed valve, and the entry into the pump, are ſimply holes in thin plates, then $b = \frac{62}{100}$ B and $c = \frac{62}{100}$ C. The entry is commonly widened or trumpet-ſhaped, which diminiſhes greatly the contraction: but there are other obſtacles in the way, ariſing from the ſtrainer uſually put round it to keep out filth. The valve may have its contraction greatly diminiſhed alſo by its box being made bell-ſhaped internally; nay, even giving it a cylindrical box, in the manner of fig. 33. is better than no box at all, as in fig. 5.; for ſuch a cylindrical box will have the unaccountable effect of the ſhort tube, and make $b = \frac{82}{100}$ B, inſtead of $\frac{62}{100}$ B. Thus we ſee that circumſtances ſeemingly very trifling may produce great effects in the performance of a pump. We ſhould have obſerved that the valve itſelf preſents an obſtacle which diminiſhes the motion, and requires an increaſe of power; and it would ſeem that in this reſpect the clack or butterfly valve is preferable to the button valve.

Example. Suppoſe the velocity of the piſton to be 2 feet or 24 inches *per* ſecond, and that the two contracted areas are each $\frac{1}{5}$ of the area of the pump, which is not much leſs than what obtains in ordinary pumps. We have $\frac{V^2}{2g}\left(\frac{A^2}{b^2}+\frac{A^2}{c^2}-1\right) = \frac{576}{768}(25+25-1)$ = 36,75 inches, and the force which we muſt add to what will merely ſupport the column is the weight of a pillar of water incumbent on the piſton, and ſomething more than three feet high. This would be a ſenſible portion of the whole force in raiſing water to ſmall heights.

We have ſuppoſed the ſuction-pipe to be of the ſame diameter with the working barrel; but it is uſual to make it of ſmaller diameter, generally equal to the water way of the fixed valve. This makes a conſiderable change in the force neceſſary to be applied to the piſton. Let a be the area of the ſuction-pipe, the area of the entry being ſtill B; and the equivalent entry without contraction being ſtill b, we have the velocity at the entrance $= \frac{AV}{b}$, and the producing head of water $= \frac{A^2V^2}{2gb^2}$. After this the velocity is changed to $\frac{AV}{a}$ in Pump. the ſuction-pipe, with which the water arrives at the valve, where it is again changed to $\frac{AV}{c}$, and requires for this change a head of water equal to $\frac{A^2V^2}{2gc^2}$. But the velocity retained in the ſuction-pipe is equivalent to the effect of a head of water $\frac{A^2V^2}{2ga^2}$. Therefore the head neceſſary for producing ſuch a current through the fixed valve, that the water may follow the piſton with the velocity V, is $\frac{A^2V^2}{2gb^2}+\frac{A^2V^2}{2gc^2}-\frac{A^2V^2}{2ga^2}$, or $= \frac{V^2}{2g}\left(\frac{A^2}{b^2}+\frac{A^2}{c^2}-\frac{A^2}{a^2}\right)$. This is evidently leſs than before, becauſe a is leſs than A, and therefore $\frac{A^2}{a^2}$ is greater than unity, which was the laſt term of the former formula. There is ſome advantage, therefore, derived from making the diameter of the ſuction-pipe leſs than that of the working barrel: but this is only becauſe the paſſage of the fixed valve is ſmaller, and the inſpection of the formula plainly points out that the area of the ſuction-pipe ſhould be equal to that of the fixed valve. When it is larger, the water muſt be accelerated in its paſſage through the valve; which is an uſeleſs expence of force, becauſe this velocity is to be immediately reduced to V in the working-barrel. If the foregoing example be computed with a equal to $\frac{1}{4}$ of A, we ſhall find the head H equal to 29 inches inſtead of 37.

But this advantage of a ſmaller ſuction-pipe is in all caſes very moderate; and the pump is always inferior to one of uniform dimenſions throughout, having the orifice at the fixed valve of the ſame area. And if theſe orifices are conſiderably diminiſhed in any proportion, the head neceſſary for overcoming the obſtacles, ſo that the required velocity V may ſtill be produced in the working barrel, is greatly increaſed. If we ſuppoſe the area a $\frac{1}{9}$ of A, which is frequently done in houſe pumps, where the diameter of the ſuction-pipe does ſeldom exceed $\frac{1}{3}$ of that of the working-barrel; and ſuppoſe every thing made in proportion to this, which is alſo uſual, becauſe the unſkilled pump-makers ſtudy a ſymmetry which ſatisfies the eye; we ſhall find that the pump taken as an example will require a head of water = 13 feet and upwards. Beſides, it muſt be obſerved that the friction of the ſuction-pipe itſelf has not been taken into the account. This alone is greater, in moſt caſes, than all the obſtructions we have been ſpeaking of; for if this pipe is three inches diameter, and that of the working-barrel is ſix, which is reckoned a liberal allowance for a ſuction-pipe, and if the fixed valve is 25 feet above the ſurface of the pit-water; the friction of this pipe will amount to one-third of the whole propelling force.

Thus we have enabled the reader to aſcertain the force neceſſary for producing any required diſcharge of water from a pump of known dimenſions: and the converſe of this determination gives us the diſcharge which will be produced by any given force. For making $\frac{A^2}{b^2}+\frac{A^2}{c^2}-\frac{A^2}{a^2}$, (which is a known quantity, reſulting from the dimenſions of the pump) = M, we

Pump. have $H = \frac{V^2}{2g} M$, and $V^2 = \frac{2gH}{M}$, and $V = \sqrt{\frac{2gH}{M}}$. Now H is that part of the natural power which we have at command which exceeds what is neceſſary for merely ſupporting the column of water. Thus, if we have a pump whoſe piſton has an area of $\frac{1}{4}$ of a ſquare foot, its diameter being $6\frac{1}{4}$ inches; and we have to raiſe the water 32 feet, and can apply a power of 525 pounds to the piſton; we wiſh to know at what rate the piſton will be moved, and the quantity of water diſcharged? Merely to ſupport the column of water of this height and diameter, requires 500 pounds. Therefore the remaining power, which is to produce the motion, is 25 pounds. This is the weight of a column 1 foot 4 inches high, and H = 1,333 feet. Let us ſuppoſe the diameter of the ſuction-pipe $\frac{1}{2}$ of that of the working-barrel, ſo that $\frac{A}{B} = 4$. We may ſuppoſe it executed in the beſt manner, having its lower extremity trumpet-ſhaped, formed by the revolution of the proper trochoid. The contraction at the entry may therefore be conſidered as nothing, and $\frac{A}{b} = 4$, and $\frac{A^2}{b^2} = 16$. We may alſo ſuppoſe the orifice of the fixed valve equal to the area of the ſuction-pipe, ſo that $\frac{A^2}{C^2}$ is alſo = 16, and there is no contraction here; and therefore $\frac{A^2}{c^2}$ is alſo 16. And laſtly, $\frac{A^2}{a^2}$ is alſo 16. Therefore $\frac{A^2}{b^2} + \frac{A^2}{c^2} - \frac{A^2}{a^2}$ or M, = 16 + 16 − 16, = 16. We have alſo $2g = 64$. Now $V = \sqrt{\frac{2gH}{M}}$. $= \sqrt{\frac{64 \times 1,333}{16}}$, = 2,309 feet, and the piſton will move with the velocity of 2 feet 4 inches nearly. Its velocity will be leſs than this, on account both of the friction of the piſton and the friction of the water in the ſuction-pipe. Theſe two circumſtances will probably reduce it to one foot eight inches; and it can hardly be leſs than this.

We have taken no notice of the friction of the water in the working-barrel, or in the ſpace above the piſton; becauſe it is in all caſes quite inſignificant. The longeſt pipes employed in our deep mines do not require more than a few inches of head to overcome it.

But there is another circumſtance which muſt not be omitted. This is the reſiſtance given to the piſton in its deſcent. The piſtons of an engine for drawing water from deep mines muſt deſcend again by their own weight in order to repeat their ſtroke. This muſt require a preponderance on that end of the working-beam to which they are attached, and this muſt be overcome by the moving power during the effective ſtroke. It makes, therefore, part of the whole work to be done, and muſt be added to the weight of the column of water which muſt be raiſed.

This is very eaſily aſcertained. Let the velocity of the piſton in its deſcent be V, the area of the pump-barrel A, and the area of the piſton-valve *a*. It is evident, that while the piſton deſcends with the velocity V, the water which is diſplaced by the piſton in a ſecond is (A—*a*) V. This muſt paſs through the hole of the piſton, in order to occupy the ſpace above, which is left by the piſton. If there were no contraction, the water would go thro' with the velocity $\frac{A-a}{a}$ V; but as there will always be ſome contraction, let the diminiſhed area of the hole (to be diſcovered by experiment) be *b*; the velocity therefore will be $V \frac{A-a}{b}$. This requires for its production a head of water $\frac{V^2}{2g}\left(\frac{A-a}{b}\right)^2$. This is the height of a column of water whoſe baſe is not A but A—*a*. Calling the denſity of water *d*, we have for the weight of this column, and the force *p* is $d \times \overline{A-a} \times \left(\frac{A-a}{b}\right)^2 \times \frac{V^2}{2g}, = \frac{d V^2 (A-a)^3}{2g b^2}$. This, we ſee again, is proportional to the ſquare of the velocity of the piſton in its deſcent, and has no relation to the height to which the water is raiſed.

If the piſton has a button valve, its ſurface is at leaſt equal to *a*; and therefore the preſſure is exerted on the water by the whole ſurface of the piſton. In this caſe we ſhall have $p = \frac{d V^2 A^3}{2g b^2}$ conſiderably greater than before. We cannot aſcertain this value with great preciſion, becauſe it is extremely difficult, if poſſible, to determine the reſiſtance in ſo complicated a caſe. But the formula is exact, if *b* can be given exactly; and we know within very moderate limits what it may amount to. In a pump of the very beſt conſtruction, with a button valve, *b* cannot exceed one-half of A; and therefore $\frac{A^3}{b^2}$ cannot be leſs than 8. In this caſe, $\frac{V^2 A^3}{2g b^2}$ will be $\frac{V^2}{8}$. In a good ſteam-engine pump V is about three feet per ſecond, and $\frac{V^2}{8}$ is about $1\frac{1}{8}$ feet, which is but a ſmall matter.

86 And in the forcing-pump.

We have hitherto been conſidering the ſucking-pump alone: but the forcing pump is of more importance, and apparently more difficult of inveſtigation.—Here we have to overcome the obſtructions in long pipes, with many bends, contractions, and other obſtructions. But the conſideration of what relates merely to the pump is abundantly ſimple. In moſt caſes we have only to force the water into an air-veſſel, in oppoſition to the elaſticity of the air compreſſed in it, and to ſend it thither with a certain velocity, regulated by the quantity of water diſcharged in a given time. The elaſticity of the air in the air-veſſel propels it along the *Main*. We are not now ſpeaking of the force neceſſary for counterbalancing this preſſure of the air in the air-veſſel, *which is equivalent to all the ſubſequent obſtructions*, but only of the force neceſſary for propelling the water out of the pump with the proper velocity.

We have in a manner determined this already. The piſton is ſolid, and the water which it forces has to paſs through a valve in the lateral pipe, and then to move in the direction of the Main. The change of direction requires an addition of force to what is neceſſary for merely impelling the water through the valve. Its quantity is not eaſily determined by any theory, and it varies according to the abruptneſs of the turn. It appears from experiment, that when a pipe is bent to a right angle, without any curvature or rounding, the velocity is diminiſhed about $\frac{1}{15}$. This would aug-

Pump. ment the head of water about $\frac{1}{9}$. This may be added to the contraction of the valve hole. Let c be its natural area, and whatever is the contraction competent to its form increaſe it $\frac{1}{18}$, and call the contracted area c. Then this will require a head of water $= \frac{V^2 A^2}{2 g c^2}$. This muſt be added to the head $\frac{V^2}{2g}$, neceſſary for merely giving the velocity V to the water. Therefore the whole is $\frac{V^2}{2g}\left(\frac{A^2}{c^2}+1\right)$; and the power p neceſſary for this purpoſe is $\frac{d A V^2}{2g}\left(\frac{A^2}{c^2}+1\right)$.

It cannot eſcape the obſervation of the reader, that in all theſe formulæ, expreſſing the height of the column of water which would produce the velocity V in the working barrel of the pump, the quantity which multiplies the conſtant factor $\frac{d A V^2}{2g}$ depends on the contracted paſſages which are in different parts of the pump, and increaſes in the duplicate proportion of the ſum of thoſe contractions. It is therefore of the utmoſt conſequence to avoid all ſuch, and to make the Main which leads from the forcing-pump equal to the working barrel. If it be only of half the diameter, it has but one-fourth of the area, the velocity in the Main is four times greater than that of the piſton, and the force neceſſary for diſcharging the ſame quantity of water is 16 times greater.

It is not, however, poſſible to avoid theſe contractions altogether, without making the main pipe wider than the barrel. For if only ſo wide, with an entry of the ſame ſize, the valve makes a conſiderable obſtruction. Unſkilful engineers endeavour to obviate this by making an enlargement in that part of the Main which contains the valve. This is ſeen in fig. 14. at the valve L. If this be not done with great judgment, it will increaſe the obſtructions. For if this enlargement is full of water, the water muſt move in the direction of its axis with a diminiſhed velocity; and when it comes into the main, it muſt again be accelerated. In ſhort, any abrupt enlargement which is to be afterwards contracted, does as much harm as a contraction, unleſs it be ſo ſhort that the water in the axis keeps its velocity till it reaches the contraction. Nothing would do more ſervice to an artiſt, who is not well founded in the theory of hydrodynamics, than to make a few ſimple and cheap experiments with a veſſel like that of fig. 37. Let the horizontal pipe be about three inches diameter, and made in joints which can be added to each other. Let the joints be about ſix inches long, and the holes from one-fourth to a whole inch in diameter. Fill the veſſel with water, and obſerve the time of its ſinking three or four inches. Each joint ſhould have a ſmall hole in its upper ſide to let out the air; and when the water runs out by it, let it be ſtopped by a peg. He will ſee that the larger the pipe is in proportion to the orifices made in the partitions, the efflux is *more diminiſhed*. We believe that no perſon would ſuſpect this who has not conſidered the ſubject minutely.

87 Uſe of experiments.

All angular enlargements, all boxes, into which the pipes from different working barrels, unite their water before it goes into a Main, muſt therefore be avoided by an artiſt who would execute a good machine; and the different contractions which are unavoidable at the ſeats of valves and the perforations of piſtons, &c. ſhould be diminiſhed by giving the parts a trumpet-ſhape. Pump.

In the air-veſſels repreſented in fig. 13. this is of very great conſequence. The throat O, through which the water is forced by the expanſion of the confined air, ſhould always be formed in this manner. For it is this which produces the motion during the returning part of the ſtroke in the pump conſtructed like fig. 13. n° 1. and during the whole ſtroke in n° 2. Neglecting this ſeemingly trifling circumſtance will diminiſh the performance at leaſt one-fifth. The conſtruction of n° 1. is the beſt, for it is hardly poſſible to make the paſſage of the other ſo free from the effects of contraction. The motion of the water during the returning ſtroke is very much contorted.

88 Acceleration of the motion of water in pumps.

There is one circumſtance that we have not taken any notice of, viz. the gradual acceleration of the motion of water in pumps. When a force is applied to the piſton, it does not in an inſtant communicate all the velocity which it acquires. It acts as gravity acts on heavy bodies; and if the reſiſtances remained the ſame, it would produce, like gravity, an uniformly accelerated motion. But we have ſeen that the reſiſtances (which are always meaſured by the force which juſt overcomes them) increaſe as the ſquare of the velocity increaſes. They therefore quickly balance the action of the moving power, and the motion becomes uniform, in a time ſo ſhort that we commit no error of any conſequence by ſuppoſing it uniform from the beginning. It would have prodigiouſly embarraſſed our inveſtigations to have introduced this circumſtance; and it is a matter of mere ſpeculative curioſity: for moſt of our moving powers are unequal in their exertions, and theſe exertions are regulated by other laws. The preſſure on a piſton moved by a crank is as variable as its velocity, and in moſt caſes is nearly in the inverſe proportion of its velocity, as any mechanician will readily diſcover. The only caſe in which we could conſider this matter with any degree of comprehenſibility is that of a ſteam-engine, or of a piſton which forces by means of a weight lying on it. In both, the velocity becomes uniform in a very ſmall fraction of a ſecond.

89 Deficiency of elementary books on this ſubject.

We have been very minute on this ſubject. For although it is the only view of a pump which is of any importance, it is hardly ever underſtood even by profeſſed engineers. And this is not peculiar to hydraulics, but is ſeen in all the branches of practical mechanics. The elementary knowledge to be met with in ſuch books as are generally peruſed by them, goes no farther than to ſtate the forces which are in equilibrio by the intervention of a machine, or the proportion of the parts of a machine which will ſet two known forces in equilibrio. But when this equilibrium is deſtroyed by the ſuperiority of one of the forces, the machine muſt move; and the only intereſting queſtion is, *what will be the motion?* Till this is anſwered with ſome preciſion, we have learned nothing of any importance. Few engineers are able to anſwer this queſtion even in the ſimpleſt caſes; and they cannot, from any confident ſcience, ſay what will be the performance of an untried machine. They gueſs at it with a ſucceſs proportioned to the multiplicity of their experience and their own ſagacity. Yet this part of mechanics is as ſuſceptible of accurate computation as the caſes of equilibrium.—We therefore thought it our duty to point out the manner of proceeding ſo circumſtantially, that every ſtep

Pun
||
Puncheon

Puncheon
||
Punctuation.

ſtep ſhould be plain and eaſy, and that conviction ſhould always accompany our progreſs. This we think it has been in our power to do, by the very ſimple method of ſubſtituting a column of water acting by its weight in lieu of any natural power which we may chance to employ.

To ſuch as wiſh to proſecute the ſtudy of this important part of hydraulics in its moſt abſtruſe parts, we recommend the peruſal of the diſſertations of Mr Pitot and Mr Boſſut, in the Memoirs of the Academy of Paris; alſo the diſſertations of the Chevalier De la Borda, 1766 and 1767; alſo the *Hydraulique* of the Chevalier De Buat. We ſhall have occaſion to conſider the motion of the water in the mains of forcing or lifting pumps which ſend the water to a diſtance, in the article *Water-Works*; where the reader will ſee how ſmall is the performance of all hydraulic machines, in compariſon of what the uſual theories, founded on equilibrium only, would make him expect.

PUN, or Punn, an expreſſion where a word has at once different meanings. The practice of punning is the miſerable refuge of thoſe who wiſh to paſs for wits, without having a grain of wit in their compoſition.—James the I. of England delighted in punning; and the taſte of the ſovereign was ſtudied by the courtiers, and even by the clergy. Hence the ſermons of that age abound with this ſpecies of falſe wit. It continued to be more or leſs faſhionable till the reign of Queen Anne, when Addiſon, Swift, Pope, and Arbuthnot, with the other real wits of that claſſical age, united their efforts to baniſh punning from polite compoſition. It is ſtill admitted ſparingly in converſation; and no one will deny that a happy pun, when it comes unſought, contributes to excite mirth in a company. A profeſſed *punſter*, however, who is always pouring forth his ſenſeleſs quibbles, as Sancho Panca poured forth his proverbs, is ſuch an intolerable nuiſance in ſociety, that we do not wonder at Pope or Swift having written a pamphlet with the title of *God's Revenge againſt Punning*.

PUNCH, an inſtrument of iron or ſteel, uſed in ſeveral arts, for the piercing or ſtamping holes in plates of metals, &c. being ſo contrived as not only to perforate, but to cut out and take away the piece. The punch is a principal inſtrument of the metal-button makers, ſhoe-makers, &c.

Punch is alſo a name for a ſort of compound drink, much uſed here, and in many parts abroad, particularly in Jamaica, and ſeveral other parts of the Weſt Indies.

Its baſis is ſpring-water; which being rendered cooler, briſker, and more acid, with lemon or lime juice, and ſweetened again to the palate with fine ſugar, makes what they call *ſherbet*; to which a proper quantity of ſpirituous liquor, as brandy, rum, or arrack, being added, the liquor commences punch.

PUNCHEON, Punchin, or *Punchion*, a little block or piece of ſteel, on one end whereof is ſome figure, letter, or mark, engraven either in creux or relievo, impreſſions whereof are taken on metal, or ſome other matter, by ſtriking it with a hammer on the end not engraved. There are various kinds of theſe puncheons uſed in the mechanical arts; ſuch, for inſtance, are thoſe of the goldſmiths, cutlers, pewterers, &c.

The puncheon, in coining, is a piece of iron ſteeled, whereon the engraver has cut in relievo the ſeveral figures, arms, effigy, inſcription, &c. that there are to be in the matrices, wherewith the ſpecies are to be marked. Minters diſtinguiſh three kinds of puncheons, according to the three kinds of matrices to be made; that of the effigy, that of the croſs or arms, and that of the legend or inſcription. The firſt includes the whole portrait in relievo; the ſecond are ſmall, ſuch only containing a piece of the croſs or arms; for inſtance, a fleur-de-lis, an harp, a coronet, &c. by the aſſemblage of all which the entire matrice is formed. The puncheons of the legend only contain each one letter, and ſerve equally for the legend on the effigy ſide and the croſs ſide. See the article Coinage.

For the puncheons uſed in ſtamping the matrices wherein the types of printing characters are caſt, ſee *Letter-Foundery*.

Puncheon is alſo uſed for ſeveral iron tools, of various ſizes and figures, uſed by the engravers en creux on metals. Seal-gravers particularly uſe a great number for the ſeveral pieces of arms, &c. to be engraven, and many ſtamp the whole ſeal from a ſingle puncheon.

Puncheon, is alſo a common name for all thoſe iron inſtruments uſed by ſtone-cutters, ſculptors, blackſmiths, &c. for the cutting, inciding, or piercing their ſeveral matters.

Thoſe of ſculptors and ſtatuaries ſerve for the repairing of ſtatues when taken out of the moulds. The lockſmiths uſe the greateſt variety of puncheons; ſome for piercing hot, others for piercing cold; ſome flat, ſome ſquare, ſome round, others oval, each to pierce holes of its reſpective figure in the ſeveral parts of locks.

Puncheon, in carpentry, is a piece of timber placed upright between two poſts, whoſe bearing is too great; ſerving, together with them, to ſuſtain ſome large weights

This term is alſo uſed for a piece of timber raiſed upright, under the ridge of a building, wherein the legs of a couple, &c. are jointed.

Puncheon, is alſo the name of a meaſure for liquids. Rum is brought from the colonies in puncheons, which are large caſks containing about 130 gallons.

PUNCTUATION, in grammar, the art of pointing, or of dividing a diſcourſe into periods, by points expreſſing the pauſes to be made therein.

The points uſed are four, viz. the period, colon, ſemi-colon, and comma. See the particular uſe of each under its proper article, Comma, Colon, Period, and Semi-colon.

In the general, we ſhall only here obſerve, that the comma is to diſtinguiſh nouns from nouns, verbs from verbs, and ſuch other parts of a period as are not neceſſarily joined together.—The ſemi-colon ſerves to ſuſpend and ſuſtain the period when too long:—the colon, to add ſome new, ſupernumerary reaſon, or conſequence, to what is already ſaid:—and the period, to cloſe the ſenſe and conſtruction, and releaſe the voice.

Punctuation is a modern art. The ancients were entirely unacquainted with the uſe of our commas, colons, &c. and wrote not only without any diſtinction of members and periods, but alſo without diſtinction of words

Punctuation.

words: which cuſtom, Lipſius obſerves, continued till the hundred and fourth Olympiad; during which time the ſenſe alone divided the diſcourſe.

What within our own knowledge at this day puts this beyond diſpute, is the Alexandrian manuſcript, which is at preſent in the king's library at the Britiſh Muſæum. Whoever examines this, will find, that the whole is written *continuo ductu*, without diſtinction of words or ſentences. How the ancients read their works written in this manner, it is not eaſy to conceive.

After the practice of joining words together ceaſed, notes of diſtinction were placed at the end of every word. In all the editions of the *Faſti Capitolini* theſe points occur. The ſame are to be ſeen on the *Columna Roſtrata*. For want of theſe, we find much confuſion in the *Chronicon Marmoreum*, and the covenant between the Smyrnæans and Magneſians, which are both now at Oxford. In Salmaſius's edition of *Dedicatio ſtatuæ rigillæ Herodis*, the like confuſion occurs, where we find ΔΕΤΡΙΤΕ and Δευρ ιτε.

Of theſe marks of diſtinction, the Walcote inſcription found near Bath may ſerve for a ſpecimen:

IVLIUSv VITALISv FABRI
CESISv LEGv XXv Vv V
STIPENDIORUMv &c.

After every word here, except at the end of a line, we ſee this mark v. There is an inſcription in Montfaucon, which has a capital letter laid in an horizontal poſition, by way of interſtitial mark, which makes one apt to think that this way of pointing was ſometimes according to the fancy of the graver.

P. FERRARIVS HERMES
CAECINIAE ⊣ DIGNAE
CONIVGI ⊣ KARRISSIMAE
NVMERIAE ⊣ &c.

Here we obſerve after the words a T laid horizontally, but not after each word, which proves this to be of a much later age than the former.

Having now conſidered that the preſent uſage of ſtops was unknown to the ancients, we proceed to aſſign the time in which this uſeful improvement of language began.

As it appears not to have taken place while manuſcripts and monumental inſcriptions were the only known methods to convey knowledge, we muſt conclude that it was introduced with the art of printing. The 14th century, to which we are indebted for this invention, did not, however, beſtow thoſe appendages we call *ſtops*: whoever will be at the pains to examine the firſt printed books, will diſcover no ſtops of any kind; but arbitrary marks here and there, according to the humour of the printer. In the 15th century, we obſerve their firſt appearance. We find, from the books of this age, that they were not all produced at the ſame time; thoſe we meet with there in uſe, being only the comma, the parentheſis, the interrogation, and the full point. To prove this, we need but look into Bale's Acts of Engliſh Votaries, black-letter, printed 1550. Indeed, in the dedication of this book, which is to Edward VI. we diſcover a colon: but, as this is the only one of the kind throughout the work, it is plain this ſtop was not eſtabliſhed at this time, and ſo warily put in by the printer; or if it was, that it was not in common uſe. Thirty years after this time, in that ſenſible and judicious performance of Sir Thomas Elyot, entitled *The Governour*, imprinted 1580, we ſee the colon as frequently introduced as any other ſtop; but the ſemi-colon and the admiration were ſtill wanting, neither of theſe being viſible in this book. In Hackluyt's voyages, printed 1599, we ſee the firſt inſtance of a ſemi-colon: and, as if the editors did not fully apprehend the propriety of its general admiſſion, it is but ſparingly introduced. The admiration was the laſt ſtop that was invented; and ſeems to have been added to the reſt in a period not ſo far diſtant from our own time.

Punctum || Punica.

Thus we ſee, that theſe notes of diſtinction came into uſe as learning was gradually advanced and improved; one invention indeed, but enlarged by ſeveral additions.

PUNCTUM SALIENS, in anatomy, the firſt rudiments of the heart in the formation of the fœtus, where a throbbing motion is perceived. This is ſaid to be eaſily obſerved with a microſcope in a brood-egg, wherein, after conception, we ſee a little ſpeck or cloud, in the middle whereof is a ſpot that appears to beat or leap a conſiderable time before the fœtus is formed for hatching. See the article FOETUS, and ANATOMY, p. 741, &c.

PUNCTUM ſtans, a phraſe by which the ſchoolmen vainly attempted to bring within the reach of human comprehenſion the poſitive eternity of God. Thoſe ſubtile reaſoners ſeem to have diſcovered that nothing, which is made up of parts whether continuous or diſcrete, can be abſolutely infinite, and that therefore eternity cannot conſiſt of a boundleſs ſeries of ſucceſſive moments. Yet, as if ſuch a ſeries had always exiſted and were commenſurate in duration with the ſupreme Being, they compared his eternity to one of the moments which compoſe the flux of time arreſted in its courſe; and to this eternal moment they gave the name of *punctum ſtans*, becauſe it was ſuppoſed to ſtand ſtill, whilſt the reſt followed each other in ſucceſſion, all vaniſhing as ſoon as they appeared. We need not waſte time or room in expoſing the abſurdity of this conceit, as we have elſewhere endeavoured, in the beſt manner that we can, to aſcertain the meaning of the words *eternity* and *infinity*, and to ſhow that they cannot be predicated of time or ſpace, of points or moments, whether flowing or ſtanding ſtill. (See METAPHYSICS, Part II. chap. 7. 8. and Part III. chap. 6.)

PUNCTURE, in ſurgery, any wound made by a ſharp-pointed inſtrument.

PUNCTURE, in farriery. See there, § xl. 3.

PUNDITS, or PENDITS, learned Bramins devoted to the ſtudy of the Shanſcrit language, and to the ancient ſcience, laws, and religion of Hindoſtan. See PHILOSOPHY, nº 4—12.

PUNICA, the POMEGRANATE TREE: A genus of the monogynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 36th order, *Pomaceæ*. The calyx is quinquefid ſuperior; there are five petals; the fruit is a multilocular and polyſpermous apple.

Species. 1. The granatum, or common pomegranate, riſes with a tree ſtem, branching numerouſly all the way from the bottom, growing 18 or 20 feet high; with ſpear-ſhaped, narrow oppoſite leaves; and the branches terminated by moſt beautiful large red flowers, ſucceeded by large roundiſh fruit as big as an orange, having a hard rind filled with ſoft pulp and numerous ſeeds. There is a variety with double flowers, remark-

ably

Puniſhment ‖ Purcell.

ably beautiful; and one with ſtriped flowers. 2. The nana, or dwarf American pomegranate, riſes with a ſhrubby ſtem branching four or five feet high, with narrow ſhort leaves and ſmall red flowers, ſucceeded by ſmall fruit; begins flowering in June, and continues till October.

Culture. Both theſe ſpecies are propagated by layers: the young branches are to be choſen for this purpoſe, and autumn is the proper time for laying them. Thoſe of the common ſort may be trained either as half or full ſtandards, or as dwarfs. But thoſe deſigned for walls muſt be managed as directed for peaches.

Uſes. The dried flowers of the double-flowered pomegranate are poſſeſſed of an aſtringent quality; for which reaſon they are recommended in diarrhœas, dyſenteries, &c. where aſtringent medicines are proper. The rind of the fruit is alſo a ſtrong aſtringent, and as ſuch is occaſionally made uſe of.

PUNISHMENT, in law, the penalty which a perſon incurs on the commiſſion of a crime. See the article *Crime and Puniſhment*.

The ingenuity of men has been much exerted to torment each other; but the following are the puniſhments that have been uſually adopted in the different countries of the world. The capital puniſhments have been beheading, crucifixion, burning, roaſting, drowning, ſcalping, hanging by the neck, the arm, or the leg, ſtarving, ſawing, expoſing to wild beaſts, rending aſunder by horſes drawing oppoſite ways, burying alive, ſhooting, blowing from the mouth of a cannon, compulſory deprivation of ſleep, rolling in a barrel ſtuck with nails pointed inwards, poiſoning, preſſing ſlowly to death by a weight laid on the breaſt, caſting headlong from a rock, tearing out the bowels, pulling to pieces with red-hot pincers, the rack, the wheel, impaling, fleaing alive, &c. &c.

The puniſhments ſhort of death have been, fine, pillory, impriſonment, compulſory labour at the mines, galleys, highways, or correction-houſe; whipping, baſtonading, mutilation by cutting away the ears, the noſe, the tongue, the breaſts of women, the foot, the hand; ſqueezing the marrow from the bones with ſcrews or wedges, caſtration, putting out the eyes, baniſhment, running the gauntlet, drumming, ſhaving off the hair, burning on the hand or forehead, &c.

PUNNING. See Pun.

PUPIL, in the civil law, a boy or girl not yet arrived at the age of puberty; i. e. the boy under 14 years, the girl under 12.

Pupil is alſo uſed in univerſities, &c. for a youth under the education or diſcipline of any perſon.

Pupil, in anatomy, a little aperture in the middle of the uvea and iris of the eye, through which the rays of light paſs to the cryſtalline humour, in order to be painted on the retina, and cauſe viſion. See Anatomy, p. 765, &c.

PURCELL (Henry), a juſtly celebrated maſter of muſic, began early to diſtinguiſh himſelf. As his genius was original, it wanted but little forming, and he roſe to the height of his profeſſion with more eaſe than others paſs through their rudiments. He was made organiſt to Weſtminſter abbey in the latter end of the reign of Charles II. In that of William, he ſet ſeveral ſongs for Dryden's *Amphytrion* and his *King Arthur*, which were received with juſt applauſe. His notes in his operas were admirably adapted to his words, and ſo echoed to the ſenſe, that the ſounds alone ſeemed capable of exciting thoſe paſſions which they never failed to do in conjunction. His muſic was very different from the Italian. It was entirely Engliſh, and perfectly maſculine. His principal works have been publiſhed under the title of *Orpheus Britannicus*. He died in 1695, in the 37th year of his age; and was interred in Weſtminſter abbey, where a monument is erected to his memory.

Purchas ‖ Purgation.

PURCHAS (Samuel), an Engliſh divine, famous for compiling a valuable collection of voyages, was born in 1577, at Thackſted in Eſſex. After ſtudying at Cambridge, he obtained the vicarage of Eaſtwood in his native county; but leaving that cure to his brother, he ſettled in London, in order to carry on the great work in which he was engaged. He publiſhed the firſt volume in folio in 1613, and the four laſt, 12 years after, under the title of *Purchas his Pilgrimage, or Relations of the world, and the Religions obſerved in all ages and places*. Meanwhile he was collated to the rectory of St Martin's, Ludgate, in London, and made chaplain to Dr Abbot, archbiſhop of Canterbury. His *Pilgrimage*, and the learned Hackluyt's *Voyages*, led the way to all the other collections of that kind, and have been juſtly valued and eſteemed. But unhappily, by his publiſhing, he involved himſelf in debt: however, he did not die in priſon, as ſome have aſſerted; but at his own houſe, about the year 1628.

PURCHASE, in law, the buying or acquiring of lands, &c. with money, by deed or agreement, and not by deſcent or right of inheritance.

Purchase, in the ſea-language, is the ſame as *draw in*: thus, when they ſay, the capſtan purchaſes a-pace, they only mean, it draws in the cable a-pace.

PURE, ſomething free from any admixture of foreign or heterogeneous matters.

PURFLEW, a term in heraldry, expreſſing ermins, peans, or any of the furs, when they compoſe a bordure round a coat of arms: thus they ſay, He beareth gules, a bordure, purflew, vairy; meaning, that the bordure is vairy.

PURGATION, the art of purging, ſcouring, or purifying a thing, by ſeparating, or carrying off any impurities found therein. Thus,

In pharmacy, purgation is the cleanſing of a medicine by retrenching its ſuperfluities. In chemiſtry, it is uſed for the ſeveral preparations of metals and minerals intended to clear them of their impurities, more uſually called *purification* and *refining*. See Refining.

In medicine, purgation is an excretory motion ariſing from a quick and orderly contraction of the fleſhy fibres of the ſtomach and inteſtines, whereby the chyle, corrupted humours, and excrements lodged therein, are protruded further and further, and at length quite excluded the body by ſtool. See Materia Medica.

For the menſtrual purgation of women, ſee Menses.

Purgation, in law, ſignifies the clearing a perſon's ſelf of a crime of which he is ſuſpected and accuſed before a judge. This purgation is either canonical or vulgar. Canonical purgation is preſcribed by the canon-law, and the form thereof in the ſpiritual court is uſually thus: The perſon ſuſpected takes his oath that he is innocent of the crime charged againſt him; and at the

ſame

PUMP.

Plate CCCCXXV.

Fig. 16.

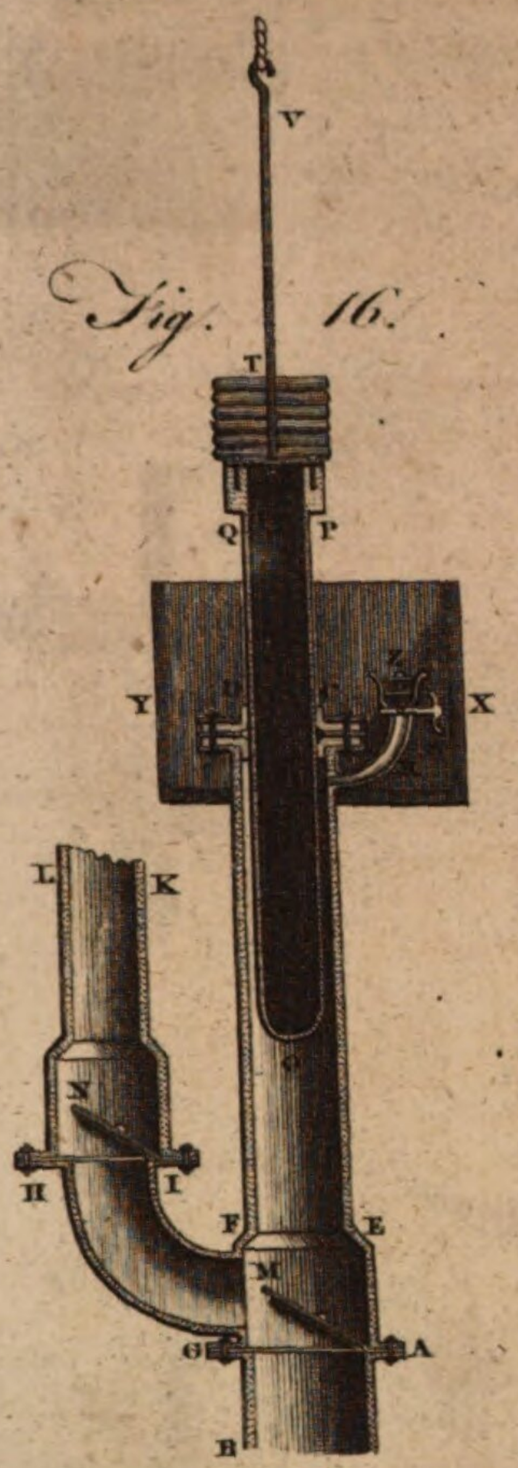


Fig. 17.

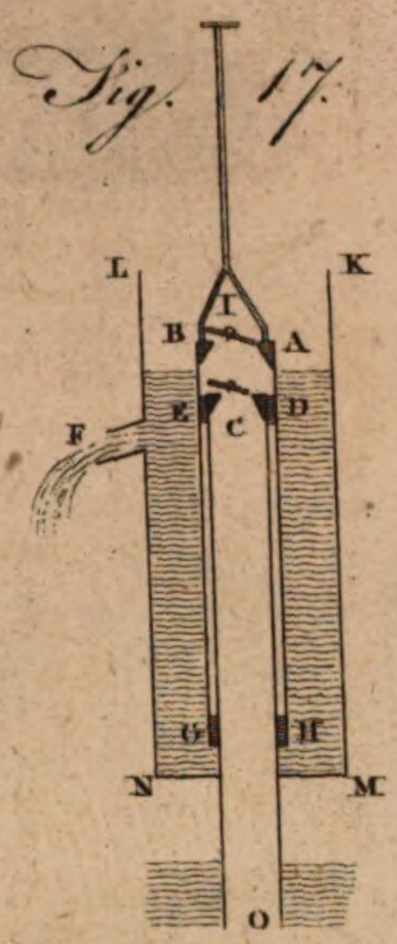


Fig. 18.

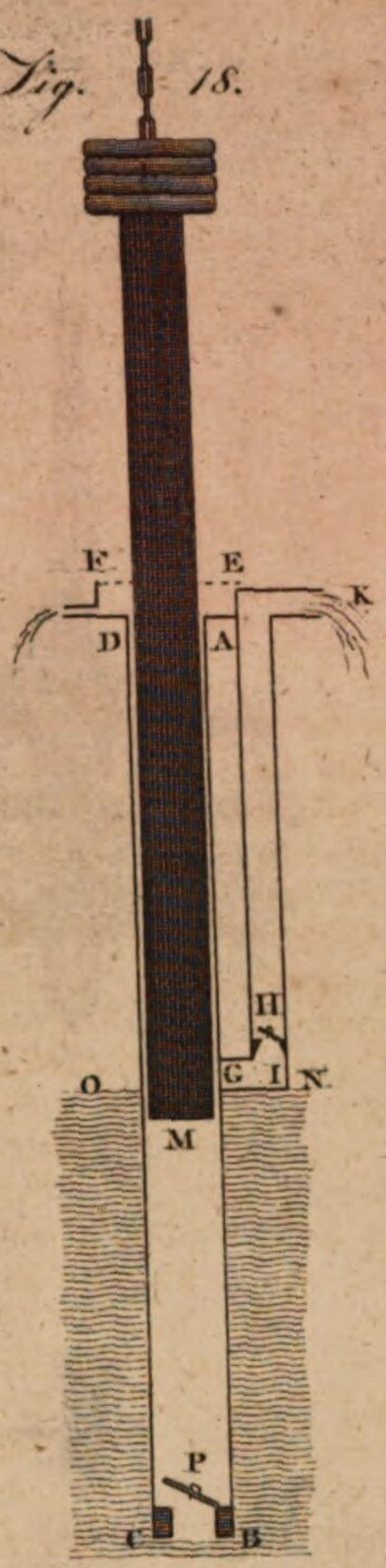


Fig. 19.

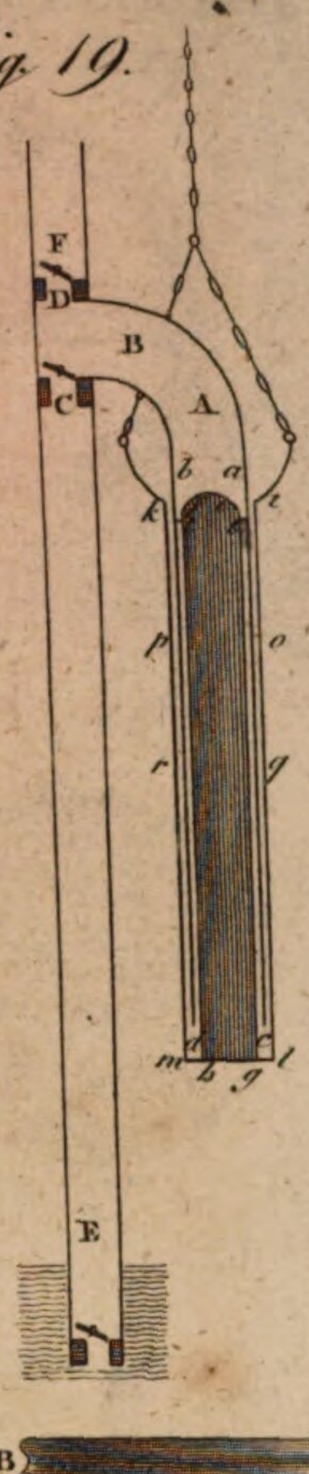


Fig. 20.

Fig. 21.

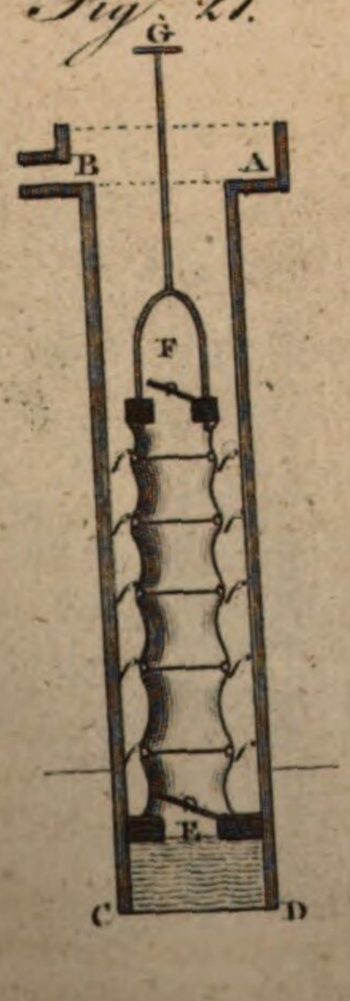


Fig. 23.

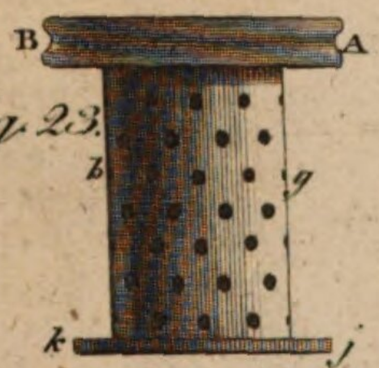


Fig. 24.

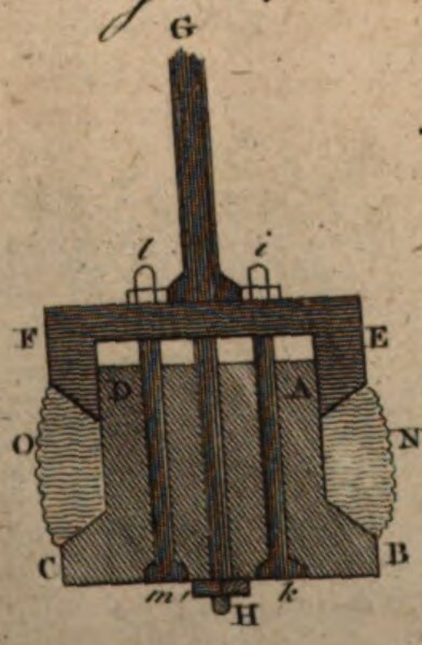


Fig. 22.

A. Bell. Pinx. Wal. Sculptor fec.

Fig. 25.

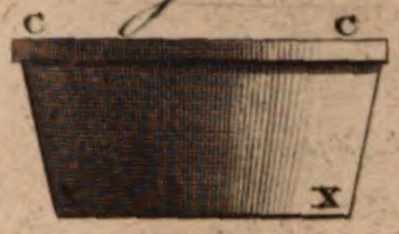


Fig. 26.

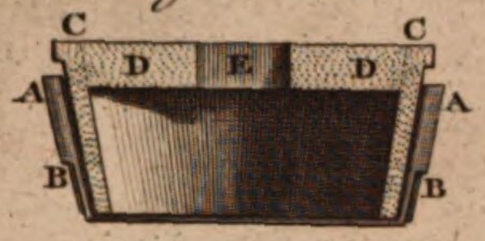


Fig. 28.

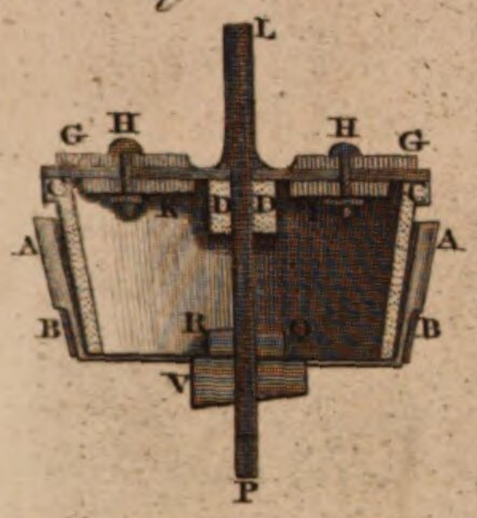


Fig. 30.

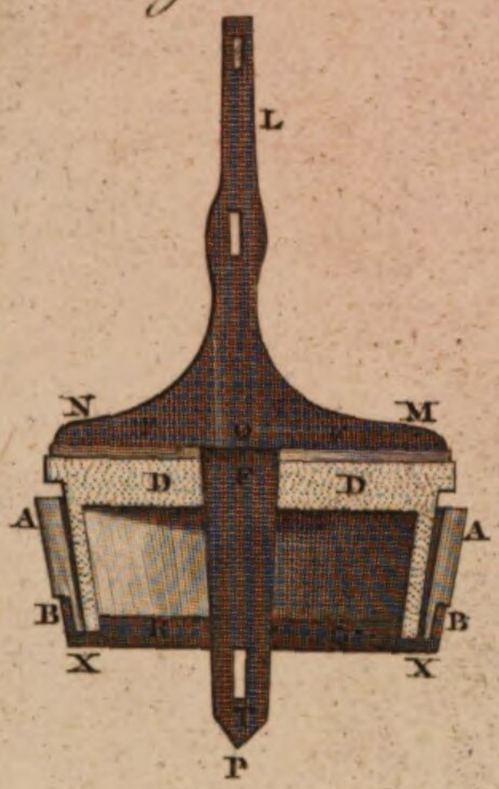


Fig. 27.

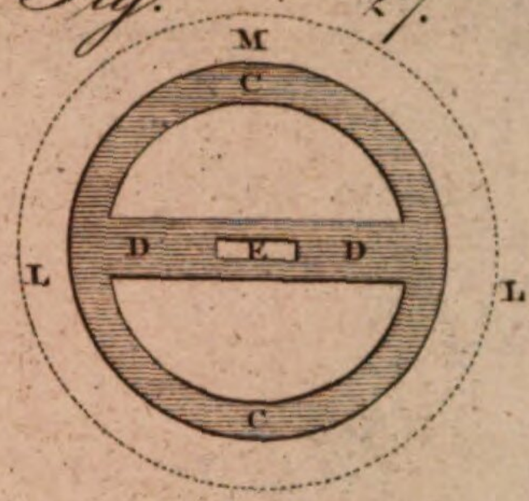


Fig. 29.

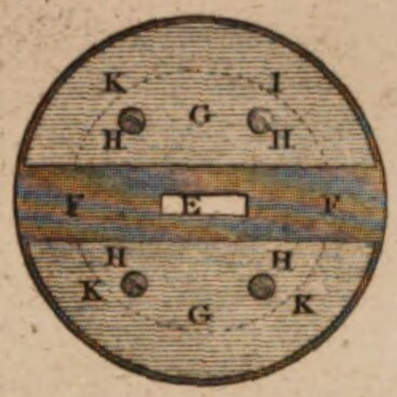


Fig. 34.

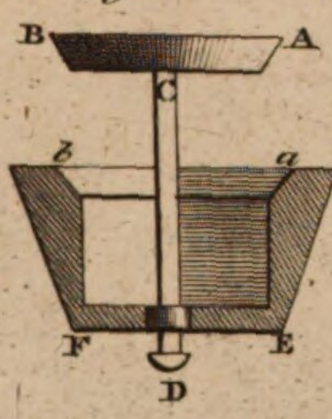


Fig. 31.

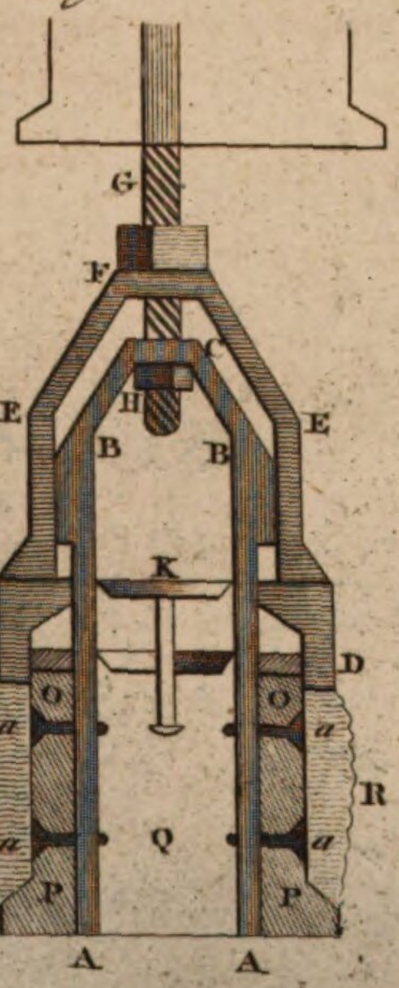


Fig. 32.

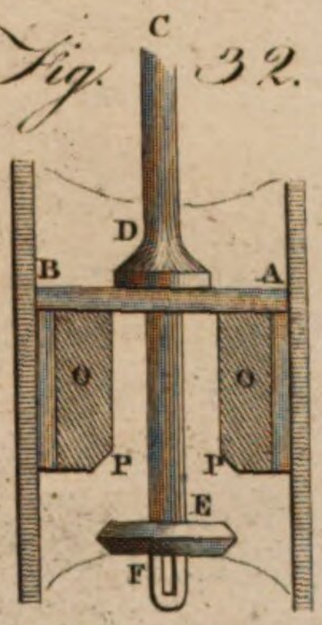


Fig. 33.

Fig. 36.

Fig. 35.

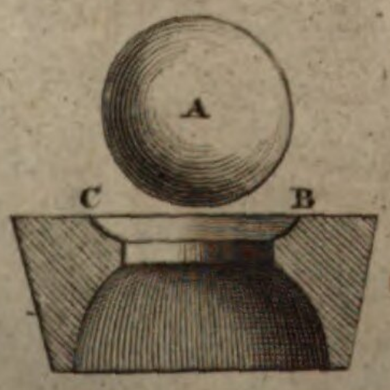
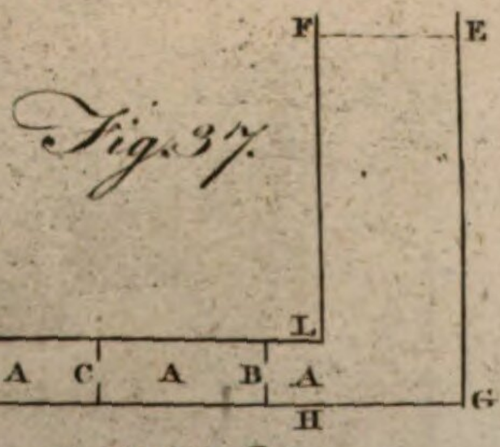


Fig. 37.



J. R. W. Pain. W. D. Sculpter fecit.

QUADRANT.

Fig. 6.

Gunters Quadrant.

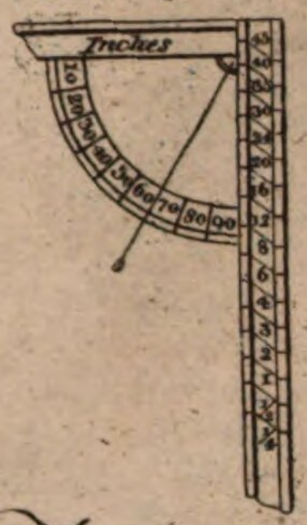


Fig. 1.

Coles Quadrant.

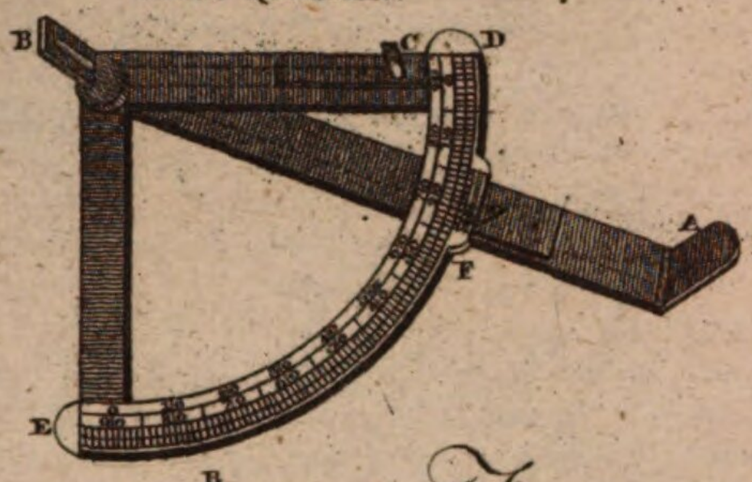


Fig. 4.

Suttons Quadrant.

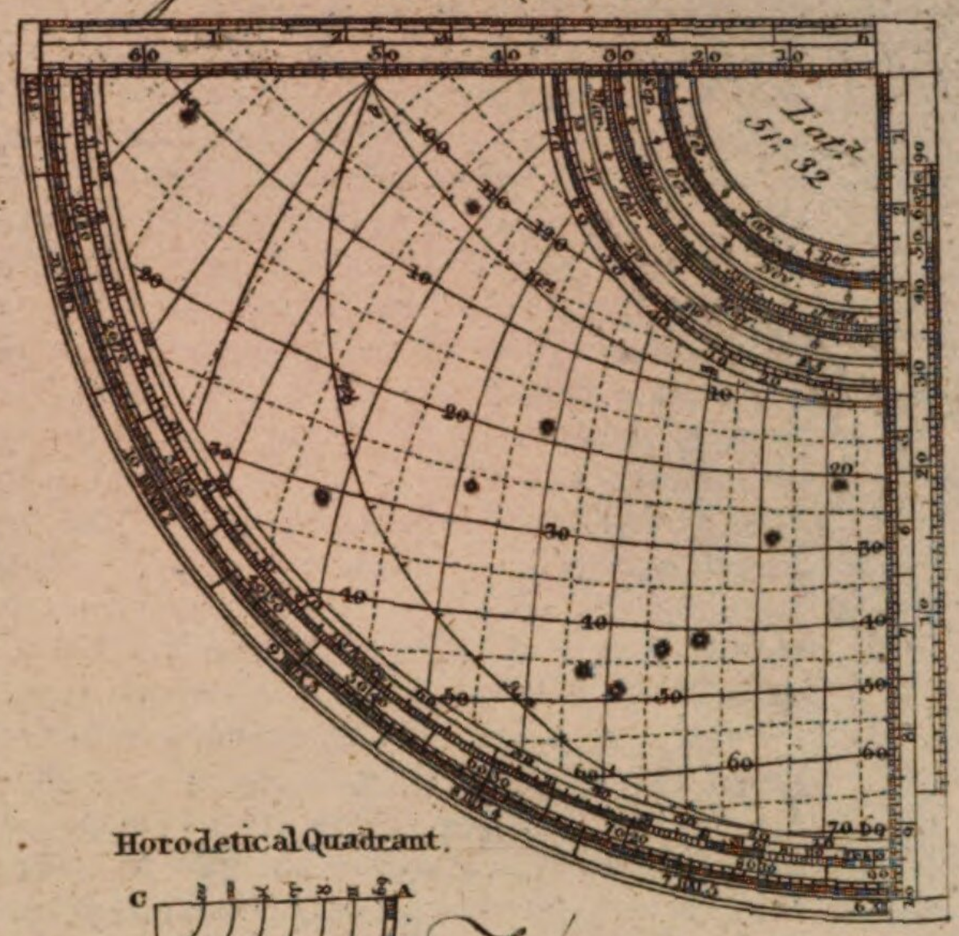


Fig. 5.

Smical Quadrant.

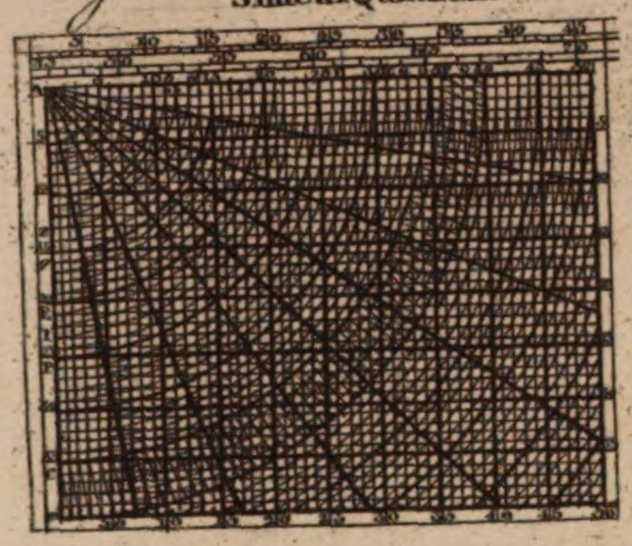


Fig. 2.

Rainbow.

Horodetical Quadrant.

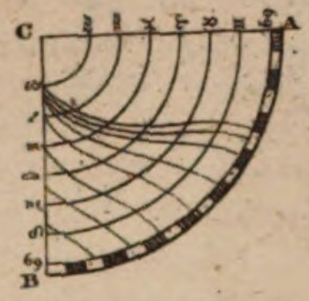
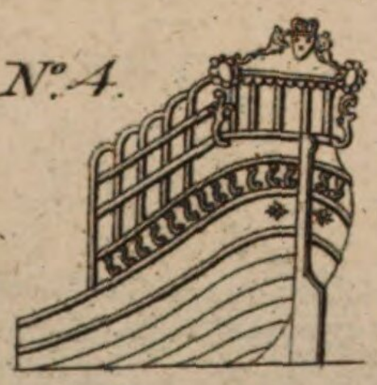


Fig. 3.

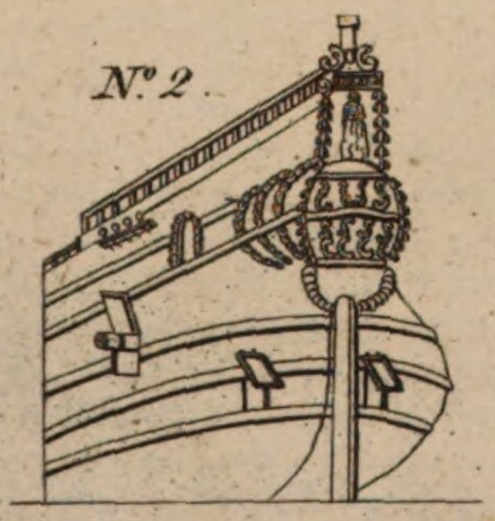
QUARTER.

N°. 7.

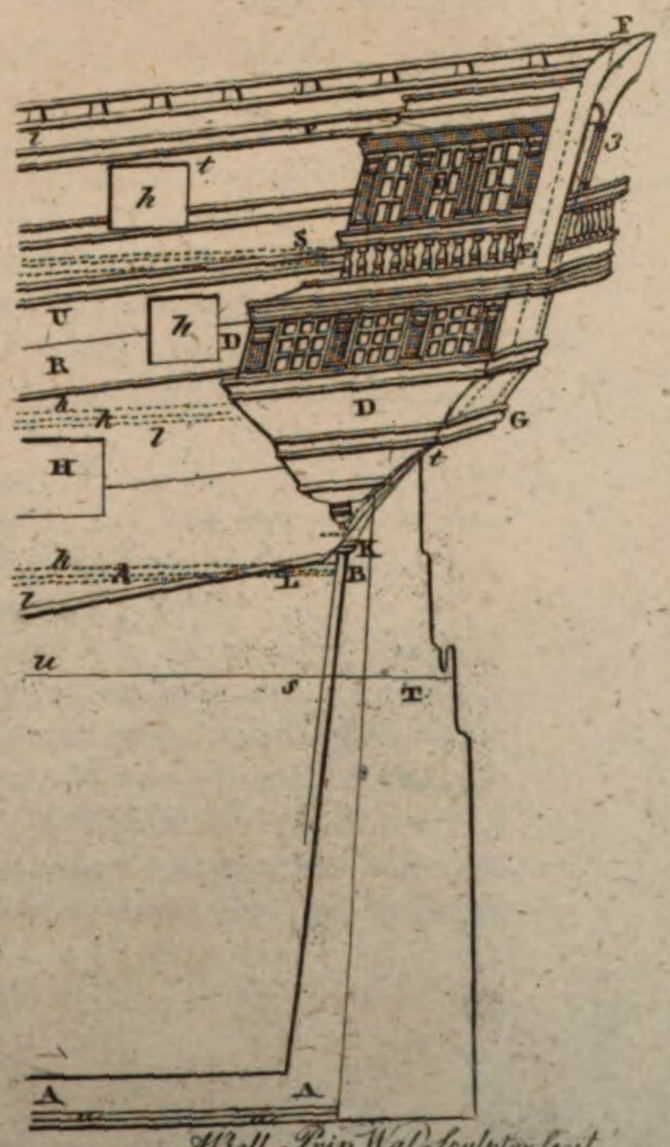
N°. 4.



N°. 2.



N°. 1.



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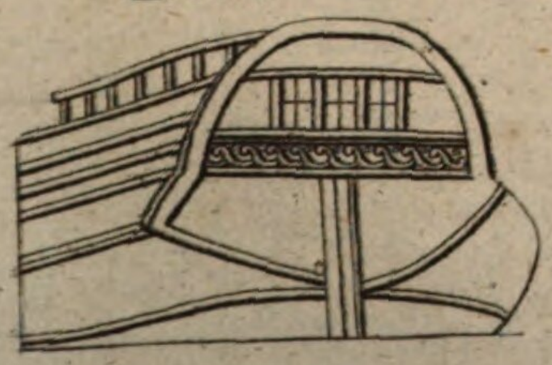

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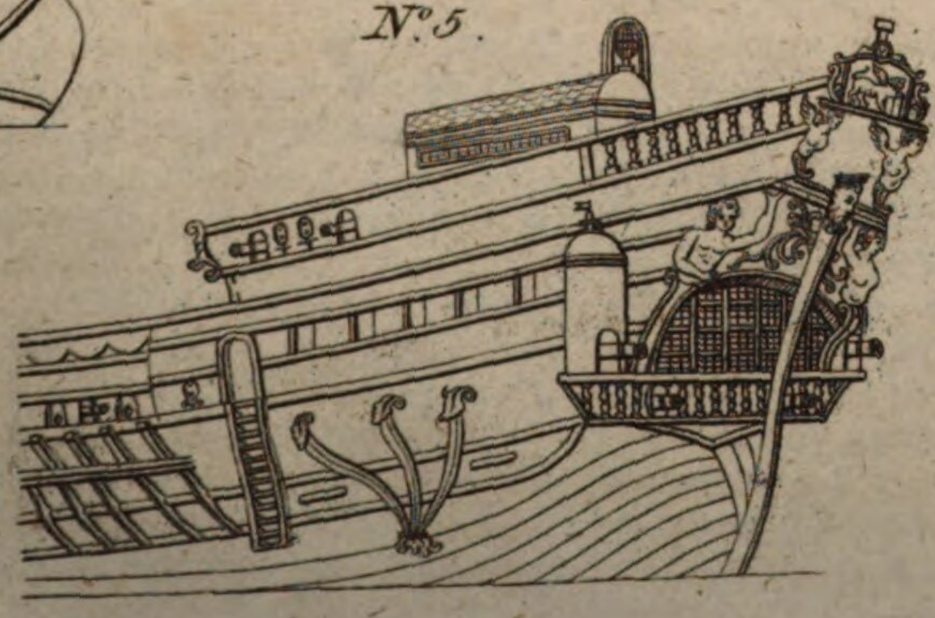

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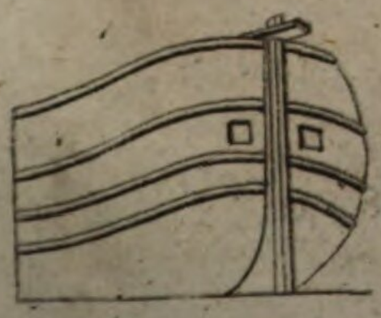

Abell Prin Wal Sculptor fecit

Purgative, Purgatory.

same time brings some of his neighbours to make oath that they believe he swears truly. Vulgar purgation was anciently by fire or water, or else by combat, and was practised here till abolished by our canons. See BATTEL *in law*, ORDEAL, &c.

PURGATIVE or *PURGING Medicines*, medicaments which evacuate the impurities of the body by stool, called also *cathartics*.

PURGATORY, a place in which the just, who depart out of this life, are supposed to expiate certain offences which do not merit eternal damnation. Broughton has endeavoured to prove, that this notion has been held by Pagans, Jews, and Mahometans, as well as by Christians; and that in the days of the Maccabees the Jews believed that sin might be expiated by sacrifice after the death of the sinner, cannot be questioned.

Papist misrepresented and represented.

Much abuse has been poured upon the church of Rome for her doctrine of purgatory, and many false representations have been made of the doctrine itself. The following view of it is taken from a work which is considered as a standard by the British Catholics. 1. Every sin, how slight soever, though no more than an idle word, as it is an offence to God, deserves punishment from him, and will be punished by him hereafter, if not cancelled by repentance here. 2. Such small sins do not deserve eternal punishment. 3. Few depart this life so pure as to be totally exempt from spots of this nature, and from every kind of debt due to God's justice. 4. Therefore few will escape without suffering something from his justice for such debts as they have carried with them out of this world; according to that rule of divine justice, by which he treats every soul hereafter according to its works, and according to the state in which he finds it in death. From these propositions, which the Papist considers as so many self-evident truths, he infers that there must be some third place of punishment; for, since the infinite goodness of God can admit nothing into heaven which is not clean and pure from all sin both great and small; and his infinite justice can permit none to receive the reward of bliss, who as yet are not out of debt, but have something in justice to suffer; there must of necessity be some place or state, where souls, departing this life, pardoned as to the eternal guilt or pain, yet obnoxious to some temporal penalty, or with the guilt of some venial faults, are purged and purified before their admittance into heaven. And this is what he is taught concerning purgatory. Which, though he knows not where it is, of what nature the pains are, or how long each soul is detained there; yet he believes, that those that are in this place, being the living members of Jesus Christ, are relieved by the prayers of their fellow members here on earth, as also by alms and masses offered up to God for their souls. And as for such as have no relations or friends to pray for them, or give alms, or procure masses for their relief; they are not neglected by the church, which makes a general commemoration of all the faithful departed in every mass, and in every one of the canonical hours of the divine office.

Such is the Popish doctrine of purgatory, which is built chiefly upon 2 Macc. xii. 43, 44, 45; St Matth. xii. 31, 32; and 1 Cor. iii. 15. By Protestants the books of Maccabees are not acknowledged to be inspired scripture; but if they were, the texts referred to would rather prove that there is no such place as purgatory, since Judas did not expect the souls departed to reap any benefit from his sin-offering till the resurrection. Our Saviour, in St Luke, speaks of remission in *this world* and in the world to *come*; but surely neither of these is purgatory. The world to come is the state after the resurrection, and the remission spoken of is the sentence of absolution to be pronounced on the penitent from the seat of general judgment. In the obscure verse referred to in the epistle to the Corinthians, the apostle is, by the best interpreters, thought to speak of the difficulty with which Christians should be saved from the destruction of Jerusalem. Of the state of souls departed he cannot well be supposed to speake, as upon disembodied spirits fire could make no impression. We cannot help, therefore, thinking with the church of England, that "the Romish doctrine of purgatory is a fond thing, vainly invented, and grounded on no warranty of scripture;" but we must confess at the same time, that it appears to us to be a very harmless error, neither hostile to virtue nor dangerous to society. See RESURRECTION.

Purification || Purlieu.

PURIFICATION, in matters of religion, a ceremony which consists in cleansing any thing from a supposed pollution or defilement.

The Pagans, before they sacrificed, usually bathed or washed themselves in water; and they were particularly careful to wash their hands, because with these they were to touch the victims consecrated to the gods. It was also customary to wash the vessel with which they made their libations. The Mahometans also use purifications previous to the duty of prayer; which are also of two kinds, either bathing, or only washing the face, hands, and feet. The first is required only in extraordinary cases, as after having lain with a woman, touched a dead body, &c. But lest so necessary a preparation for their devotions should be omitted, either where water cannot be had, or when it may be of prejudice to a person's health, they are allowed in such cases to make use of fine sand, or dust instead of it; and then they perform this duty by clapping their open hands on the sand, and passing them over the parts, in the same manner as if they were dipped in water.

There were also many legal purifications among the Hebrews. When a woman was brought to bed of a male child, she was esteemed impure for 40 days; and when of a female, for 60: at the end of which time she carried a lamb to the door of the temple to be offered for a burnt-offering, and a young pigeon or turtle for a sin-offering; and by this ceremony she was cleansed or purified.

PURIM, or *The FEAST of LOTS*, a solemn festival of the Jews, instituted in memory of the deliverance they received, by means of Mordecai and Esther, from Haman's wicked attempt to destroy them.

PURITAN, a name formerly given in derision to the dissenters from the church of England, on account of the profession to follow the pure word of God, in opposition to all traditions and human constitutions. It was likewise given in the primitive church to the Novatian schismatics, because they would never admit to communion any one who from dread of death had apostatized from the faith.

PURITY, the freedom of any thing from foreign admixture.

PURITY of Style. See ORATORY, p. 411, &c.

PURLIEU, signifies all that ground near any forest,

Purlins ‖ Purulent.

which being made foreſt by King Henry II. Richard I. and King John, was afterwards by perambulations and grants of Henry III. ſevered again from the ſame, and made purlieu; that is to ſay, pure and free from the laws of the foreſt.—The word is derived from the French *pur* "pure," and *lieu* "place."

PURLINS, in building, thoſe pieces of timber that lie acroſs the rafters on the inſide, to keep them from ſinking in the middle of their length.

By the act of parliament for rebuilding London, it is provided, that all purlins from 15 feet 6 inches to 18 feet 6 inches long, be in their ſquare 9 inches and 8 inches; and all in length from 18 feet 6 inches to 21 feet 6 inches, be in their ſquare 12 inches and 9 inches.

PURPLE, a colour compoſed of a mixture of red and blue. See *Colour-Making*, n° 29 and Dying, n° 92.

PURPURA, in natural hiſtory. See Murex: where we have given an account of the Tyrian method of dying purple with a liquid extracted from the fiſh. It has been affirmed, however, that no ſuch method was ever practiſed. "At Tyre (ſays Mr Bruce) I engaged two fiſhermen, at the expence of their nets, to drag in thoſe places where they ſaid ſhell-fiſh might be caught, in hopes to have brought out one of the famous purple-fiſh. I did not ſucceed; but in this I was, I believe, as lucky as the old fiſhers had ever been. The purple fiſh at Tyre ſeems to have been only a concealment of their knowledge of cochineal; as, had they depended upon the fiſh for their dye, if the whole city of Tyre applied to nothing elſe but fiſhing, they would not have coloured 20 yards of cloth in a year."

PURPURE, in heraldry. The colour ſo called, which ſignifies *purple*, is in engraving repreſented by diagonal lines, from the left to the right. See Heraldry, p. 441. and Plate CCXXVII. fig. ii. n° 6.

It may ſerve to denote an adminiſtrator of juſtice, a lawgiver, or a governor equal to a ſovereign: and, according to G. Leigh, if it is compounded with

Or,	it ſignifies	Riches.
Arg.		Quietneſs.
Gul.		Politics.
Az.		Fidelity.
Ver.		Cruelty.
Sab.		Sadneſs.

PURPUREUS. See Convolvulus, n° 3.

PURRE, or Perkin. See Husbandry, n° 238.

PURSER, an officer aboard a man of war, who receives her victuals from the victualler, ſees that it be well ſtowed, and keeps an account of what he every day delivers to the ſteward. He alſo keeps a liſt of the ſhip's company, and ſets down exactly the day of each man's admiſſion, in order to regulate the quantity of proviſions to be delivered out, and that the paymaſter or treaſurer of the navy may iſſue out the deburſements, and pay off the men, according to his book.

PURSLAIN, in botany. See Portulaca.

PURVIEW, a term uſed by ſome lawyers for the body of an act of parliament, or that part which begins with "Be it enacted &c." as contradiſtinguiſhed from the preamble.

PURULENT, in medicine, ſomething mixed with, or partaking of, pus or matter.

Pus ‖ Puteoli.

PUS, in medicine, a white or yellowiſh matter deſigned by nature for the healing and cementing of wounds and ſores.

The origin and formation of pus is as much unknown as that of any other animal fluid. In an inaugural diſſertation publiſhed at Edinburgh by Dr Hendy, the author ſuppoſes pus to be a ſecreted fluid. It has been thought by many, that pus is either a ſediment from ſerum when beginning to putrefy, or that it is the ſame fluid inſpiſſated by the heat of the body. But both theſe opinions are refuted by ſome experiments of our author, which ſhow, that pus is much leſs inclined to putrefaction than ſerum, and the putrefaction of both is haſtened by an addition of ſome of the red part of the blood. Some other experiments were made in order to try whether pus could be artificially produced. A thin piece of lamb's fleſh, applied to an ulcer diſcharging laudable pus, and covered over with lead, did not aſſume the appearance of pus, but became fetid, and was much leſſened. Serum, in its inflammatory and in its ordinary ſtate, and lymph in different ſtates, were applied to the ſame ulcer, which ſtill diſcharged good pus; but none of theſe were converted into pus; on the contrary, they became very putrid.

In oppoſition to theſe arguments of our author, however, it may be alleged, that if pus was a ſecreted fluid, the veſſels by which it was ſecreted would certainly be viſible; but no ſuch thing has ever been obſerved: on the contrary, it is certain that pus cannot be formed unleſs the air is excluded from the wound. Theſe diſputes, however, are of no great conſequence: but in ſome caſes it becomes a matter of real importance to diſtinguiſh pus from mucus; as thus we may be enabled to know whether a cough is conſumptive, or merely catarrhous. See Mucus. Mr Home, in a diſſertation on the properties of pus, in which he avails himſelf of the experiments of Mr Hunter, as delivered in his *Phyſiological Lectures*, ſays, "that the characteriſtic of pus is its being compoſed of globules; and he thinks that the preſence of globules ſeems to depend upon the pus being in a perfect ſtate. It differs from the blood in the colour of the globules; in their not being ſoluble in water, which thoſe of the blood are; and from the fluid in which they ſwim being coagulable by a ſolution of ſal ammoniac, which ſerum is not." Reſpecting the formation of pus, our author adopts the idea ſuggeſted by Mr Hunter, that the veſſels of the part aſſume the nature of a gland, and ſecrete a fluid which becomes pus. Mr Home aſcertains, by experiment, that pus, at its formation, is not globular, but a tranſparent fluid, of a conſiſtence, in ſome ſort, reſembling jelly; and that the globules are formed while lying upon the ſurface of the ſore; requiring, in ſome inſtances, while the influence of the external air is excluded, fifteen minutes for that purpoſe.

PUSTULE, a pimple, or ſmall eruption on the ſkin full of pus; ſuch as the eruptions of the ſmall-pox.

PUTAMINEÆ, (from *putamen* "a ſhell,") the name of the 25th order of Linnæus's fragments of a natural method; conſiſting of a few genera of plants allied in habit, whoſe fleſhy ſeed-veſſels or fruit is frequently covered with a hard woody ſhell. See Botany, p. 462.

PUTEOLI, (Livy, Strabo): a town of Campania;

Puteoli || Putrefaction.

Swinburne's Travels in the Two Sicilies.

so called either from its wells, there being many hot and cold ſprings thereabouts; or from its ſtench, *putor*, cauſed by ſulphureous exhalations, (Varro, Strabo). It is now called *Puzzuoli*, and is pleaſantly and advantageouſly ſituated for trade. In a very remote age, the Cumeans made it their arſenal and dockyard; and to this naval eſtabliſhment gave the ſublime appellation of *Dicearchia* or *Juſt Power*.

The Romans were well aware of the utility of this port, and took great pains to improve its natural advantages. Nothing remains of their works but a line of piers, built to break the force of a rolling ſea: they are vulgarly called the *bridge of Caligula*, becauſe that madman is ſaid to have marched in triumph from Puzzuoli to Baia on a bridge; but his was a bridge of boats.

The ruins of its ancient edifices are widely ſpread along the adjacent hills and ſhores. An amphitheatre ſtill exiſts entire in moſt of its parts, and the temple of Serapis offers many curious ſubjects of obſervation; half of its buildings are ſtill buried under the earth thrown upon it by volcanical commotions, or accumulated by the crumblings of the hill; the incloſure is ſquare, environed with buildings for prieſts and baths for votaries; in the centre remains a circular platform, with four flights of ſteps up to it, vaſes for fire, a centrical altar, rings for victims, and other appendages of ſacrifice, entire and not diſplaced; but the columns that held its roof have been removed to the new palace of Caſerta (ſee CASERTA). Behind this round place of worſhip ſtand three pillars without capitals, part of the pronaos of a large temple; they are of cipolline marble, and at the middle of their height are full of holes eaten in them by the file-fiſh *.

* *Pholas Dactylus*, Linn.

The preſent city contains near 10,000 inhabitants, and occupies a ſmall peninſula; the cathedral was a pagan temple, dedicated to the divinities that preſided over commerce and navigation. E. Long. 14. 40. N. Lat. 41. 15.

In the neighbourhood of Puteoli are many relicks of antient grandeur, of which none deſerves more attention than the Campanian way paved with lava, and lined on each ſide with venerable towers, the repoſitories of the dead, which are richly adorned with ſtucco in the inſide. This road was made in a moſt ſolid expenſive manner by order of Domitian, and is frequently the ſubject of encomium in the poems of Statius.

PUTI CARAJA, in botany, is a genus of Indian plants, of which the characters, as given by Sir William Jones in the Aſiatic Reſearches, vol. ii. p. 351. are theſe. The calyx is five-cleft, the corolla has five equal petals, the pericarpium a thorny legumen and two ſeeds, the leaves oval and pinnated, and the ſtem armed. "The ſeeds (ſays the learned Preſident) are very bitter, and perhaps tonic; ſince one of them, bruiſed and given in two dozes, will, as the Hindoos aſſert, cure an intermittent fever."

PUTORIUS, in zoology. See MUSTELA.

PUTREFACTION, one of the natural proceſſes, directly oppoſite to the life of animals and vegetables, by which organized bodies are diſſolved, and reduced to what may be called their *original elements*.

Putrefaction differs from chemical ſolution; becauſe, in the latter, the diſſolved bodies are kept in their ſtate of ſolution by being combined with a certain agent from which they cannot eaſily be ſeparated; but in putrefaction, the agent which diſſolves the body appears not to combine with it in any manner of way, but merely to ſeparate the parts from each other.—It differs alſo from the reſolution of bodies by diſtillation with violent fire; becauſe, in diſtillation new and permanent compounds are formed, but by putrefaction every thing ſeems to be reſolved into ſubſtances much more ſimple and indeſtructible than thoſe which are the reſult of any chemical proceſs. Putrefaction.

The bodies moſt liable to putrefaction are thoſe of animals and vegetables, eſpecially when full of juices. Stones, though by the action of the weather they will moulder into duſt, yet ſeem not to be ſubject to any thing like a real putrefaction, as they are not reſolved into any other ſubſtance than ſand, or ſmall duſt, which ſtill preſerves its lapideous nature. In like manner, vegetables of any kind, when deprived of their juices by drying, may be preſerved for many ages without being ſubjected to any thing like a putrefactive proceſs. The ſame holds good with reſpect to animals; the parts of which, by ſimple drying, may be preſerved in a ſound ſtate for a much longer time than they could be without the previous exhalation of their juices.

Putrefaction is generally allowed to be a kind of fermentation, or rather to be the laſt ſtage of that proceſs; which, beginning with the vinous fermentation, goes on through the acetous, to the ſtage of putridity, where it ſtops. It is argued, however, and ſeemingly not without a great deal of reaſon, that if putrefaction is a fermentation, it muſt neceſſarily be a kind diſtinct from either the vinous or acetous; ſince we frequently obſerve that it takes place where neither the vinous nor the acetous ſtages have gone before; of conſequence, it muſt be, in ſome caſes at leaſt, entirely independent of and unconnected with them. In ſeveral other reſpects it differs ſo much from theſe proceſſes, that it ſeems in ſome degree doubtful whether it can with propriety be called a *fermentation* or not. Both the vinous and acetous fermentations are attended with a conſiderable degree of heat: but in the putrefaction of animal matters eſpecially, the heat is for the moſt part ſo ſmall, that we cannot be certain whether there is any degree of it or not produced by the proceſs. In caſes, indeed, where the quantity of corrupting animal matter is very great, ſome heat may be perceived: and accordingly Dr Monro tells us, that he was ſenſible of heat on thruſting his hand into the fleſh of a dead and corrupting whale. But the moſt remarkable difference between the putrefactive fermentation and that of the vinous and acetous kinds is, that the end of both theſe proceſſes is to produce a new and permanent compound; but that of the putrefactive proceſs is not to produce any new form, but to deſtroy, and reſolve one which already exiſts into the original principles from which all things ſeem to proceed. Thus, the vinous fermentation produces ardent ſpirits; the acetous, vinegar: but putrefaction produces nothing but earth, and ſome effluvia, which, though moſt diſagreeable, and even poiſonous to the human body, yet, being imbibed by the earth and vegetable creation, give life to a new race of beings. It is commonly ſuppoſed, indeed, that volatile alkali is a production of the putrefactive proceſs: but this ſeems liable to diſpute. The vapour of pure volatile alkali is not hurtful to the human frame, but that of putrefying ſubſtances is exceedingly ſo; and, excepting in the caſe of urine, the

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generation of volatile alkali in putrid ſubſtances is very equivocal. This ſubſtance, which produces more alkali than any other, is much leſs offenſive by its putrid fetor than others; and all animal ſubſtances produce a volatile alkali on being expoſed to the action of fire, of quicklime, or of alkaline ſalts. In theſe caſes the volatile alkali is not ſuppoſed to be produced by the quicklime or fixed ſalt, but only to be extricated from a kind of ammoniacal ſalt pre-exiſting in the animal matters; the probability is the ſame in the other caſe, viz. that volatile alkali is not produced, but only extricated, from theſe ſubſtances by putrefaction.

The only thing in which the putrefactive fermentation agrees with the other kinds is, that in all the three there is an extrication of fixed air. In the putrefactive proceſs, it has been thought that this eſcape of the fixed air deprives the body of its coheſion: and Dr Macbride has written a treatiſe, in which he endeavours to prove, that fixed air is the very power of coheſion itſelf, and that all bodies when deprived of their fixed air entirely loſe their coheſion. According to this hypotheſis, the cauſe of putrefaction is the eſcape of fixed air: but it is impoſſible to give a reaſon why fixed air, after having ſo long remained in a body, and preſerved its coheſion, ſhould of a ſudden begin to fly off without being acted upon by ſomething elſe. To a ſimilar objection the hypotheſis of thoſe is liable, who ſuppoſe putrefaction to be occaſioned by the eſcape of phlogiſton; for phlogiſton is now known to be a chimera: and though it were a reality, it would not fly off without ſomething to carry it off, any more than fixed air. Animalcules have been thought to be the cauſe of putrefaction: but if animal ſubſtances are covered ſo as to exclude the acceſs of flies or other inſects, no ſuch animalcules are to be diſcovered though putrefaction has taken place; and indeed it requires little proof to convince us, that animals are produced in corrupted bodies only becauſe ſuch ſubſtances prove a proper nidus for the eggs of the parent inſects.

To underſtand the true cauſe of putrefaction, we muſt take notice of the circumſtances in which the proceſs goes on moſt rapidly. Theſe are, heat, a little moiſture, and confined air. Extreme cold prevents putrefaction, as well as perfect dryneſs; and a free circulation of air carries off the putrid effluvia; a ſtagnation of which ſeems to be neceſſary for carrying on the proceſs. It ſeems alſo to hold pretty generally, that putrefying bodies ſwell and become ſpecifically lighter; for which reaſon the carcaſes of dead animals, after having ſunk in water, riſe to the top and float. This laſt phenomenon, as has been obſerved under the article Blood, n° 29. ſhows that theſe bodies have received a certain quantity of an elaſtic principle from the air, which thus ſwells them up to ſuch a ſize. It may be ſaid indeed, that this increaſe of ſize in putrefying bodies is owing only to the extrication of air within themſelves: but this amounts to the ſame thing; for the air which exiſts internally in the body of any animal, is entirely diveſted of elaſticity while it remains there, and only ſhows its elaſtic properties upon being extricated. The elaſtic principle which combines with the air fixed in the animal ſubſtance, therefore, muſt come from the external atmoſphere; and conſequently the agent in putrefaction muſt be the elaſtic principle of the atmoſphere itſelf, probably the ſame with elementary fire.

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But, granting this to be true, it is difficult to ſhow why putrefaction ſhould not take place in a living body as well as in a dead one; ſeeing the one is as much expoſed to the action of the air as the other. This difficulty, however, is not peculiar to the preſent hypotheſis; but will equally occur whatever we may ſuppoſe the cauſe of putrefaction to be. The difficulty ſeems to be a little cleared up by Dr Prieſtley, who ſhows, that, by means of reſpiration, the body is freed from many noxious effluvia which would undoubtedly deſtroy it; and by the retention of which, he thinks, a living body would putrefy as ſoon as a dead one. The way in which reſpiration prevents the putrefaction of the body, is evidently the ſame with that in which the wind prevents fiſh or fleſh hung up in it from becoming putrid. The conſtant inſpiration of the air is like a ſtream of that element continually blown upon the body, and that not only upon its ſurface, but into it; by which means putrefaction is prevented in thoſe parts that are moſt liable to become putrid. On the other hand, the elaſtic principle received from the air by the blood *, by invigorating the powers of life, quickening the circulation, and increaſing perſpiration, enables the body to expel noxious particles from other parts of the body which cannot conveniently be expelled by the lungs.

* See *Blood*, n° 29.

This leads us to conſider the reaſon why a free expoſure to the air prevents the coming on of putrefaction, or why the confining of the putrid effluvia ſhould be ſo neceſſary to this proceſs. Here it will be proper to recollect, that putrefaction is a ſimple reſolution of the body into earth, air, &c. of which it ſeems originally to have been compoſed. This reſolution is evidently performed by an expanſive power ſeemingly ſituated in every particle of the body. In conſequence of this principle, the body firſt ſwells, then burſts, flies off in vapour, and its particles fall aſunder from each other. The action of the putrefactive proceſs, then, is analogous to that of fire, ſince theſe are the very properties of fire, and the very effects which follow the action of fire upon any combuſtible body. It is therefore exceedingly probable, that the agent in the air, which we have all along conſidered as the cauſe of putrefaction, is no other than fire itſelf; that is, the ethereal fluid expanding itſelf everywhere, as from a centre to a circumference. The force of the fluid, indeed, is much leſs in putrefaction than in actual ignition; and therefore the effects alſo take place in a much ſmaller degree, and require a much longer time: nevertheleſs, the ſame circumſtances that are neceſſary for keeping up the action of fire, are alſo neceſſary for keeping up the putrefactive proceſs. One of theſe is a free acceſs of air, yet without too violent a blaſt; for as fire cannot burn without air, neither can it endure too much of it: thus a candle goes out if put under a receiver, and the air exhauſted; and it will do the ſame if we blow violently upon it. In like manner, putrefaction requires a certain quantity of air, much leſs indeed than fire: and as it requires leſs to ſupport it, ſo it can alſo endure much leſs air than fire; for a ſtream of air which would not put out a fire, will effectually prevent putrefaction. The cauſe of this in both is the ſame. Fire cannot burn becauſe the vapour is carried off too faſt; and thus the latent heat, which ought to ſupport the flame §, is entirely diſſipated. In like manner putrefaction is as certainly attended with an

§ See the article *Flame*.

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an emiſſion of azotic gas as fire is with an emiſſion of flame. Theſe gaſes contain a great quantity of latent heat ‡, or of the expanſive principle already mentioned; and if theſe are carried off with greater rapidity than the heat of the atmoſphere can produce them, the conſequence muſt be, that an oppoſite principle to that which produces putrefaction, namely, a principle of cold, or condenſation, inſtead of expanſion, muſt take place, and the body cannot putrefy. That this muſt be the caſe, is evident from the property which all evaporations have of producing cold ‖; and it is well known that a briſk current of air promotes evaporation to a great degree. Hence alſo the reaſon is evident why bodies are preſerved uncorrupted by cold; for thus the action of the expanſive principle is totally overcome and ſuſpended, ſo that none of its effects can be perceived.

‡ See *Phlogiſton*.

‖ See *Evaporation*, n° 3.

Thus we may ſee, that one reaſon why an animal body does not putrefy while alive, is its ventilation, as we may call it, by reſpiration; and another is, the continual acceſſion of new particles, leſs diſpoſed to putrefy than itſelf, by the food and drink which is conſtantly taken in. But if either of theſe ways of preventing the commencement of this proceſs are omitted, then putrefaction will take place as well in a living as in a dead body. Of the truth of this laſt fact we have innumerable inſtances. When air is infected with the putrid effluvia of marſhes, and thus the natural effluvia are not carried off from the human body, but, on the contrary, ſome enter into it which are not natural to it, the moſt putrid diſeaſes are produced. The ſame thing happens from the putrid effluvia of dead bodies. Of this we have a remarkable inſtance in the fever which took place in Germany in the war of 1755: one reaſon of which is ſaid to have been an infection of the air by the vaſt numbers of people killed in battle, to which was added a calm in the atmoſphere for a long time; the putrid effluvia being by this prevented from flying off *. When Mr Holwell with 145 others were impriſoned in the black-hole at Calcutta, after paſſing a night in that diſmal habitation, he found himſelf in a high putrid fever. When ſailors in long voyages are obliged to feed upon putrid aliments; when, thro' ſtormy weather, they are much expoſed to wet; in the one caſe the putreſcent effluvia being kept from flying off, and in the other a greater quantity being thrown into the body than what it naturally contains, the ſcurvy, malignant fevers, &c. make their appearance (A). Neither can theſe diſeaſes be removed without removing every one of the cauſes juſt now mentioned: for as putrid diſeaſes will be the conſequence of confined air, naſtineſs, &c. though the proviſions be ever ſo good; ſo, on the other hand, if the proviſions be bad, the beſt air, and moſt exact cleanlineſs, nay, the beſt medicines in the world, will be of no ſervice; as hath been often obſerved in the ſcurvy.

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From this account of the nature, cauſe, and method of preventing putrefaction by means of a current of air, we may eaſily ſee the reaſon why it does not take place in ſome other caſes alſo. Bodies will not putrefy *in vacuo*, becauſe there the atmoſphere has not acceſs to impart its elaſtic principle; and though in the vacuum itſelf the principle we ſpeak of does undoubtedly exiſt, yet its action there is by far too weak to decompoſe the ſtructure of an animal body. In extreme cold, the reaſon why putrefaction does not take place has been already ſhown. If the heat is extremely great, the proceſs of ignition or burning takes place inſtead of putrefaction. If the body is very dry, putrefaction cannot take place, becauſe the texture is too firm to be decompoſed by the weak action of the elaſtic principle. Putrefaction may alſo be prevented by the addition of certain ſubſtances; but they are all of them ſuch as either harden the texture of the body, and thus render it proof againſt the action of the elaſtic fluid, or, by diſſolving its texture entirely, bring it into a ſtate ſimilar to what it would be brought by

* See *Medicine*, n° 167.

(A) This aeriform fluid, which is exhaled from animal bodies in a ſtate of putrefaction, acts at certain times more powerfully than at others, and is indeed in one ſtage of the proceſs infinitely more noxious than any other elaſtic fluid yet diſcovered. In the Gentleman's Magazine for Auguſt 1788, Dr St John, informs us, that he knew a gentleman who, by ſlightly touching the inteſtines of a human body beginning to liberate this corroſive gas, was affected with a violent inflammation, which in a very ſhort ſpace of time extended up almoſt the entire length of his arm, producing an extenſive ulcer of the moſt foul and frightful appearance, which continued for ſeveral months, and reduced him to a miſerable ſtate of emaciation. The ſame writer mentions a celebrated profeſſor who was attacked with a violent inflammation of the nerves and fauces, from which he with difficulty recovered, merely by ſtooping for an inſtant over a body which was beginning to give forth this deleterious fluid. Hence he infers, that the ſame gas modified or mixed, or united with others, may be the occaſion of the plague, which has ſo often threatened to annihilate the human ſpecies. It is happy, however, for mankind that this particular ſtage of putrefaction continues but for a few hours; and, what may appear very remarkable, this deſtructive gas is not very diſagreeable in ſmell, and has nothing of that abominable and loathſome fetor produced by dead bodies in a leſs dangerous ſtate of corruption; but has a certain ſmell totally peculiar to itſelf, by which it may be inſtantly diſcovered by any one that ever ſmelled it before. This is an object very worthy the attention of phyſicians: it is both extremely intereſting, and very little known; but at the ſame time it is a ſtudy in the higheſt degree unpleaſant, from the deteſtable ſmell and naſtineſs which attend the putrefaction of animal bodies; and a man muſt be armed with uncommon philanthropy and reſolution to attempt it.

Dr St John thinks it probable that there is a rapid fixation of the baſis of vital air in dead bodies at a certain ſtate of putrefaction, on account of the luminous appearance which they ſometimes make, and which exiſts but for a few hours: but whether this luminous appearance takes place in every body, or whether it precedes or follows the exhalations of the corroſive gas above-mentioned, he had not, when he wrote his paper, been able to diſcover.

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by the utmoſt power of putrefaction, ſo that the proceſs cannot then take place. Thus various kinds of ſalts and acids harden the texture of animal ſubſtances, and thus are ſucceſsfully uſed as antiſeptics. The ſame thing may be ſaid of ardent ſpirits; while oils and gums of various kinds prove antiſeptic by a total excluſion of air, which is neceſſary in ſome degree for carrying on the proceſs of putrefaction. Many vegetables, by the aſtringent qualities they poſſeſs, harden the texture of animal ſubſtances, and thus prove powerfully antiſeptic; while, on the other hand, fixed alkaline ſalts, quicklime, and cauſtic volatile alkali, though they prevent putrefaction, yet they do it by diſſolving the ſubſtances in ſuch a manner that putrefaction could do no more though it had exerted its utmoſt force. There is only one other antiſeptic ſubſtance whoſe effects deſerve to be conſidered, and that is ſugar. This, tho' neither acid nor alkaline, is yet one of the moſt effectual means of preventing putrefaction: and this ſeems to be owing to its great tendency to run into the vinous fermentation, which is totally inconſiſtent with that of putrefaction; and this tendency is ſo great, that it can ſcarce be counteracted by the tendency of animal ſubſtances to putrefy in any circumſtances whatever.

Some kinds of air are remarkably antiſeptic, though this ſubject has not been ſo fully inquired into as could be wiſhed. The moſt powerful of them in this reſpect is the nitrous air; next to it, is fixed air; but the powers of the other airs are not ſo well known. It is probable that the antiſeptic properties of fixed and nitrous air, are owing to their quality of extinguiſhing fire, or at leaſt that the principle is the ſame; but, till the nature of theſe two kinds of air are better known, little can be ſaid with certainty on the ſubject.

Sir John Pringle has made experiments to determine the powers of certain ſubſtances to promote or to prevent putrefaction. From theſe experiments he has formed the following Table, ſhowing the relative antiſeptic powers of the ſaline ſubſtances mentioned. Having found that two drams of beef put in a phial with two ounces of water, and placed in a heat equal to 90° of Fahrenheit's thermometer, became putrid in 14 hours, and that 60 grains of ſea-ſalt preſerved a ſimilar mixture of beef and water more than 30 hours, he made the antiſeptic power of the ſea-ſalt a ſtandard, to which he compared the powers of the other ſalts. The algebraic character + ſignifies, that the ſubſtance to which it is annexed had a greater antiſeptic power than is expreſſed by the numbers:

Sea-ſalt, or the ſtandard - -	1
Sal-gem - - -	1+
Vitriolated tartar - -	2
Spiritus Mindereri - -	2
Soluble tartar - - -	2
Sal diureticus - - -	2+
Crude ſal ammoniac - -	3
Saline mixture - -	3
Nitre - - -	4+
Salt of hartſhorn - -	4+
Salt of wormwood - -	4+
Borax - - -	12
Salt of amber - - -	20
Alum - - -	30

N. B. The quantities of ſpiritus Mindereri and of the ſaline mixture were ſuch, that each of them contained as much alkaline ſalt as the other neutral ſalts.

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Myrrh, aloes, aſafœtida, and terra Japonica, were found to have an antiſeptic power 30 times greater than the ſtandard. Gum ammoniacum and ſagapenum ſhowed little antiſeptic power.

Of all reſinous ſubſtances, camphor was found to reſiſt putrefaction moſt powerfully. Sir John Pringle believes that its antiſeptic power is 300 times greater than that of ſea-ſalt.

Chamomile flowers, Virginian ſnake-root, pepper, ginger, ſaffron, contrayerva root, and galls, were found to be 12 times more antiſeptic than ſea-ſalt.

Infuſions of large quantities of mint, angelica, ground-ivy, green tea, red-roſes, common wormwood, muſtard, and horſe-radiſh, and alſo decoctions of poppy-heads, were more antiſeptic than ſea-ſalt.

Decoctions of wheat, barley, and other farinaceous grains, checked the putrefaction by becoming ſour.

Chalk, and other abſorbent powders, accelerated the putrefaction, and reſolved meat into a perfect mucus. The ſame powders prevented an infuſion of farinaceous grains from becoming mucilaginous and ſour.

One dram of ſea-ſalt was found to preſerve two drams of freſh beef in two ounces of water, above 30 hours, uncorrupted, in a heat equal to that of the human body, or above 20 hours longer than meat is preſerved in water without ſalt: but half a dram of ſalt did not preſerve it more than two hours longer than pure water. Twenty-five grains of ſalt had little or no antiſeptic quality. Twenty grains, 15 grains, but eſpecially 10 grains only of ſea-ſalt, were found to accelerate and heighten the putrefaction of two drams of fleſh.—Theſe ſmall quantities of ſea-ſalt did alſo ſoften the fleſh more than pure water.

The ſame learned and ingenious phyſician made experiments to diſcover the effects of mixing vegetable with animal matters.

Two drams of raw beef, as much bread, and an ounce of water, being beat to the conſiſtence of pap, and expoſed to 90° of heat according to Fahrenheit's thermometer, began to ferment in a few hours, and continued in fermentation during two days. When it began to ferment and ſwell, the putrefaction had begun; and in a few hours afterwards, the ſmell was offenſive. Next day the putrid ſmell ceaſed, and an acid taſte and ſmell ſucceeded. Freſh alimentary vegetables, as ſpinach, aſparagus, ſcurvy-graſs, produced ſimilar effects as bread on fleſh, but in a weaker degree. From ſeveral other experiments he found, that animal ſubſtances excite the fermentation of vegetable ſubſtances, and that the latter ſubſtances correct the putreſcency of the former.

By adding ſaliva to a ſimilar mixture of fleſh, bread, and water, the fermentation was retarded, moderated, but rendered of twice the uſual duration, and the acid produced at laſt was weaker than when no ſaliva was uſed.

By adding an oily ſubſtance to the common mixture of fleſh, bread, and water, a ſtronger fermentation was produced, which could not be moderated by the quantity of ſaliva uſed in the former experiment, till ſome fixed alkaline ſalt was added; which ſalt was found, without ſaliva, to ſtop ſuddenly very high fermentations.

He did not find that ſmall quantities of the following ſalts,

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falts, fal ammoniac, nitre, vitriolated tartar, fal diureticus, falt of hartſhorn, falt of wormwood, were ſeptic, as ſmall quantities of ſea-falt were.

Sugar was found to reſiſt putrefaction at firſt, as other ſalts do, and alſo to check the putrefaction after it had begun by its own fermentative quality, like bread and other fermentative vegetables.

Lime-water made ſome ſmall reſiſtance to putrefaction.

Port-wine, ſmall-beer, infuſions of bitter vegetables, of bark, and the juice of antiſcorbutic plants, retarded the fermentation of mixtures of fleſh and bread. But an unſtrained decoction of bark conſiderably increaſed that fermentation.

Crabs-eyes accelerated and increaſed the fermentation of a mixture of fleſh and bread.

Lime-water neither retarded nor haſtened the fermentation of ſuch a mixture: but when the fermentation ceaſed, the liquor was neither putrid nor acid, but ſmelt agreeably.

Fleſh pounded in a mortar was found to ferment ſooner than that which had not been bruiſed.

The tough inflammatory cruſt of blood was found to be moſt putreſcent; next to which the craſſamentum, or red coagulated maſs; and laſtly the ſerum.

Dr Macbride's experiments confirm many of thoſe above related, eſpecially thoſe which ſhow that the fermentation of vegetable ſubſtances is increaſed by a mixture of animal or putreſcent matter; that the putreſcency of the latter is corrected by the fermentative quality of the former; and that the putrefaction and fermentation of mixtures of animal and vegetable ſubſtances were accelerated by additions of abſorbent earths and of Peruvian bark. He alſo found, that although unburnt calcareous earths were ſeptic, quicklime and lime-water prevented putrefaction, but that they deſtroyed or diſſolved the texture of fleſh.

The experiments of the author of the *Eſſai pour ſervir à l'Hiſtoire de la Putrefaction*, ſhow that metallic ſalts, reſinous powders, extracts of bark, and opium, are very powerfully antiſeptic, and that ſalts with earthy baſes are leſs antiſeptic than any other ſalts.

PUTTOCK-SHROUDS. See *Puttock-SHROUDS*.

PUTTY, in its popular ſenſe, is a kind of paſte compounded of whiting and lintſeed oil, beaten together to the conſiſtence of a thick dough.

It is uſed by glaziers for the faſtening in the ſquares of glaſs in ſaſh-windows, and by painters for ſtopping up the crevices and clefts in timber and wainſcots, &c.

PUTTY ſometimes alſo denotes the powder of calcined tin, uſed in poliſhing and giving the laſt gloſs to works of iron and ſteel.

TERRA PUZZULANA, or POZZOLANA, is a greyiſh kind of earth uſed in Italy for building under water. The beſt is found about Puteoli, Baiæ, and Cumæ, in the kingdom of Naples, from the firſt of which places it derives its name. It is a volcanic product, compoſed of heterogeneous ſubſtances, thrown out from the burning mouths of volcanoes in the form of aſhes; ſometimes in ſuch large quantities, and with ſo great violence, that whole provinces have been covered with it at a conſiderable diſtance. In the year 79 of the common era, the cities of Herculaneum, Pompeia, and Stabia, although at the diſtance of many miles from Veſuvius, were, nevertheleſs, buried under the matters of theſe dreadful eruptions; as Bergman relates in his *Treatiſe of the Volcanic Products*. This volcanic earth is of a grey, brown, or blackiſh colour; of a looſe, granular, or duſty and rough, porous or ſpongy texture, reſembling a clay hardened by fire, and then reduced to a groſs powder. It contains various heterogeneous ſubſtances mixed with it. Its ſpecific gravity is from 2500 to 2800; and it is, in ſome degree, magnetic: it ſcarcely effervеſces with acids, though partially ſoluble in them. It eaſily melts *per ſe*; but its moſt diſtinguiſhing property is, that it hardens very ſuddenly when mixed with $\frac{1}{3}$ of its weight of lime and water; and forms a cement, which is more durable in water than any other.

Puzzulana ‖ Pycnoſtyle.

According to Bergman's Analyſis, 100 parts of it contain from 55 to 60 of ſiliceous earth, 20 of argillaceous, five or ſix of calcareous, and from 15 to 20 of iron. Its effects, however, in cement may perhaps depend only on the iron which has been reduced into a particular ſubſtance by means of ſubterraneous fires; evident ſigns of which are obſervable in the places where it is obtained. If the ſlate in Henneberg, or Kennekulle in the province of Weſtergottland, ſhould happen to get fire, the uppermoſt ſtratum, which now conſiſts of a mixture of iron and different kinds of rocks, called *graberg* in the account given of them, they might perhaps be changed partly into ſlag and partly into *terra puzzolana*.

It is evidently a martial argillaceous marl, that has ſuffered a moderate heat. Its hardening power ariſes from the dry ſtate of the half-baked argillaceous particles, which makes them imbibe water very rapidly, and thus accelerates the deſiccation of the calcareous part; and alſo from the quantity and ſemiphlogiſticated ſtate of the iron contained in it. It is found not only in Italy but in France, in the provinces of Auvergne and Limoges; and alſo in England and elſewhere.

PUZZUOLI. See PUTEOLI.

PYANEPSIA, in antiquity, an Athenian feſtival celebrated on the ſeventh day of the month *Pyanepſion*; which, according to the generality of critics, was the ſame with our September.

Plutarch refers the inſtitution of this feaſt to Theſeus, who, after the funeral of his father, on this day paid his vows to Apollo, becauſe the youths who returned with him ſafe from Crete then made their entry into the city. On this occaſion, theſe young men putting all that was left of their proviſions into one kettle, feaſted together on it, and made great rejoicing. Hence was derived the cuſtom of boiling pulſe on this feſtival. The Athenians likewiſe carried about an olive branch, bound about with wool, and crowned with all ſorts of firſt-fruits, to ſignify that ſcarcity and barrenneſs were ceaſed, ſinging in proceſſion a ſong. And when the ſolemnity was over, it was uſual to erect the olive-branch before their doors, as a preſervative againſt ſcarcity and want.

PYCNOSTYLE, in the ancient architecture, is a building where the columns ſtand very cloſe to each other; only one diameter and a half of the column being allowed for the intercolumniations.

According to Mr Evelyn, the pycnoſtyle chiefly belonged to the compoſite order, and was uſed in the moſt magnificent buildings; as at preſent in the periſtyle at St Peter's at Rome, which conſiſts of near 300 columns;

Pygargus || Pylus.

lumns; and in ſuch as yet remain of the ancients, among the ruins of Palmyra.

PYGARGUS, in ornithology, a ſpecies of FALCO.

PYGMALION, in fabulous hiſtory, a king of Cyprus, who, being diſguſted at the diſſolute lives of the women of his iſland, reſolved to live in perpetual celibacy; but making a ſtatue of ivory, he fell ſo paſſionately in love with it, that the high feſtival of Venus being come, he fell down before the altar of that goddeſs, and beſought her to give him a wife like the ſtatue he loved. At his return home, he embraced, as uſual, his ivory form, when he perceived that it became ſenſible by degrees, and was at laſt a living maid, who found herſelf in her lover's arms the moment ſhe ſaw the light. Venus bleſſed their union; and, at the end of nine months, ſhe was delivered of a boy, who was named *Paphos*.

PYGMY, a perſon not exceeding a cubit in height. This appellation was given by the ancients to a fabulous nation inhabiting Thrace; who brought forth young at five years of age, and were old at eight: theſe were famous for the bloody war they waged with the cranes. As to this ſtory, and for the natural hiſtory of the true pygmy, ſee SIMIA.

PYKAR, a broker in India, inferior to thoſe called *dallals*, who tranſacts the buſineſs at firſt hand with the manufacturer, and ſometimes carries goods about for ſale.

PYKE, a watchman in India, employed as a guard at night. Likewiſe a footman or runner on buſineſs. They are generally armed with a ſpear.

PYLADES, a ſon of Strophius, king of Phocis, by one of the ſiſters of Agamemnon. He was educated together with his couſin Oreſtes, with whom he formed the moſt inviolable friendſhip, and whom he aſſiſted to revenge the murder of Agamemnon, by aſſaſſinating Clytemneſtra and Ægyſthus. He alſo accompanied him in Taurica Cherſoneſus; and for his ſervices Oreſtes rewarded him, by giving him his ſiſter Electra in marriage. Pylades had by her two ſons, Medon and Strophius. The friendſhip of Oreſtes and Pylades became proverbial.

PYLORUS, in anatomy, the under orifice of the ſtomach. See ANATOMY, n° 91.

PYLUS (anc. geog.), a town of Elis; its ruins to be ſeen on the road from Olympia to Elis, (Pauſanias); ſituated between the mouths of the Peneus aud Sellees, near Mount Scollis, (Strabo.) Built by Pylas of Megara, and deſtroyed by Hercules, (Pauſanias.)—Another Pylus in Triphylia, (Strabo); by which the Alpheus runs, (Pauſanias); on the confines of Arcadia, and not in Arcadia itſelf, (id.)—A third in Meſſenia, (Strabo, Ptolemy); ſituated at the foot of Mount Ægaleus on the ſea-coaſt, over-againſt the iſland Sphagea or Sphacteria: built by Pylas, and ſettled by a colony of Leleges from Megara; but thence expelled by Neleus and the Pelaſgi, and therefore called *Nelea*. (Homer.) A ſandy territory. The royal reſidence of Neleus, and of Neſtor his ſon: the more ancient and more excellent Pylus; whence the proverb *Pylus ante Pylum*, (Ariſtophanes, Plutarch), uſed when we want to repreſs the arrogance and pride of any one: ſaid to be afterwards called *Coryphaſium*. It made a figure in the Peloponneſian war; for being rebuilt by the Athenians, it proved of great benefit to them for the ſpace of 15 years, and of much annoyance to the Lacedemonians, (Thucydides). All the three *Pyli* were ſubject to Neſtor, (Strabo.) Pyramid.

PYRAMID, in geometry, a ſolid ſtanding on a triangular, ſquare, or polygonal baſis, and terminating in a point at the top; or, according to Euclid, it is a ſolid figure, conſiſting of ſeveral triangles, whoſe baſes are all in the ſame plane, and have one common vertex.

Pyramids are ſometimes uſed to preſerve the memory of ſingular events, and ſometimes to tranſmit to poſterity the glory and magnificence of princes. But as they are eſteemed a ſymbol of immortality, they are moſt commonly uſed as funeral monuments and temples to the gods. Such is that of Ceſtius at Rome; the pyramids of Daſhur drawn by Pocock; and thoſe other celebrated ones of Egypt, as famous for the enormity of their ſize as their antiquity. Of theſe the largeſt are the pyramids of *Geeza*, ſo called from a village of that name on the banks of the Nile, diſtant from them about 11 miles. The three which moſt attract the attention of travellers ſtand near one another on the weſt ſide of the river, almoſt oppoſite to Grand Cairo, and not far from the place where the ancient Memphis ſtood. They were viſited by M. Savary, of whoſe deſcription of them we ſhall here give an abſtract.

He took his journey in the night-time, in order to get up to the top of the great one by ſunriſe. Having got within ſight of the two great ones, while the full moon ſhone upon them, he informs us, that they appeared, at the diſtance of three leagues, like two points of rock crowned by the clouds.

It is in the rich territory which ſurrounds them that fable has placed the Elyſian fields. The canals which interſect them are the Styx and Lethe.

"The aſpects of the pyramids varied according to the circuits he made in the plain, and the poſition of the clouds diſplayed themſelves more and more to view. At half paſt three in the morning we arrived (ſays he) at the foot of the greateſt. We left our clothes at the gate of the paſſage which leads to the inſide, and deſcended, carrying each of us a flambeau in his hand. Towards the bottom you muſt creep like ſerpents to get into the interior paſſage, which correſponds with the former. We mounted it on our knees, ſupporting ourſelves with our hands againſt the ſides. Without this precaution one runs the riſk of ſlipping on the inclined plane, where the ſlight notches are inſufficient to ſtop the foot, and one might fall to the bottom. Towards the middle we fired a piſtol, the frightful noiſe of which, repeated in the cavities of this immenſe edifice, continued a long time, and awakened thouſands of bats, which flying round us, ſtruck againſt our hands and faces, and extinguiſhed ſeveral of our wax candles. They are much larger than the European bats. Arrived above, we entered a great hall, the gate of which is very low. It is an oblong ſquare, wholly compoſed of granite. Seven enormous ſtones extend from one wall to the other, and form the roof. A ſarcophagus made of a ſingle block of marble lies at one end of it. It is empty; and the lid of it has been wrenched off. Some pieces of earthen vaſes lie around it. Under this beautiful hall is a chamber not ſo large, where you find the entrance to a conduit filled with rubbiſh. After examining theſe caves, where daylight never penetrated, we deſcended the ſame way, taking care not to fall in-

PYROTECHNY.

Plate CCCCXXVIII.

Fig. 1.

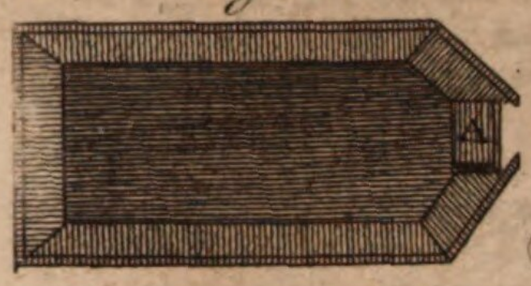


Fig. 2.

Fig. 3

Fig. 5.

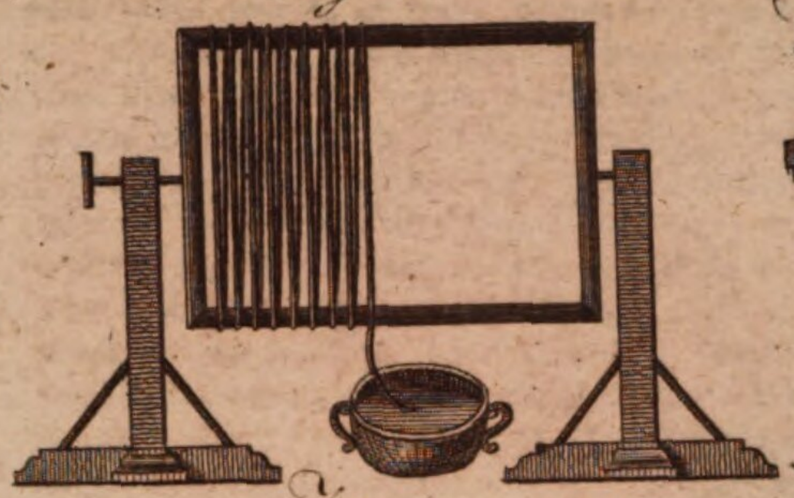


Fig. 6.

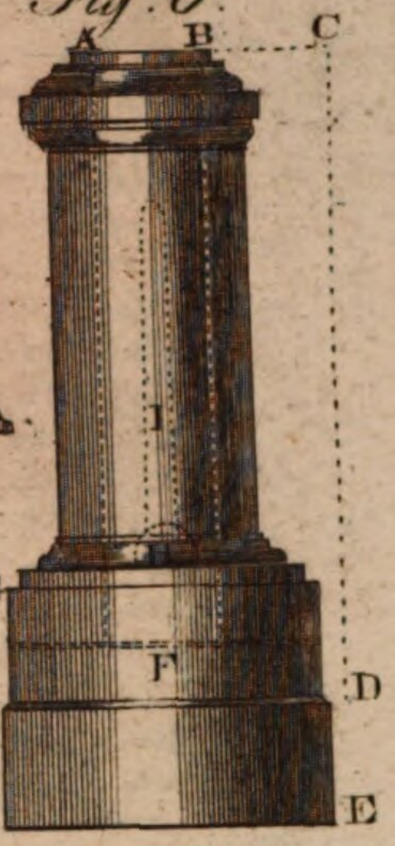


Fig. A

Fig. 7.

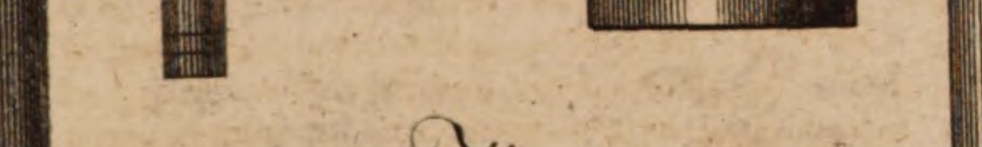


Fig. 8.

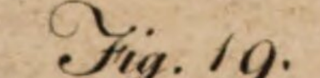


Fig. 9. Fig. 10. Fig. 11.

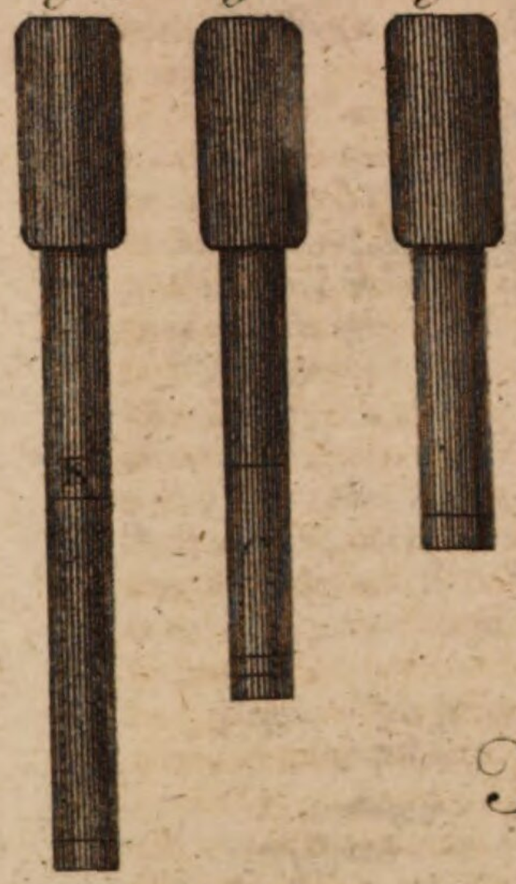


Fig. 12. Fig. 13.

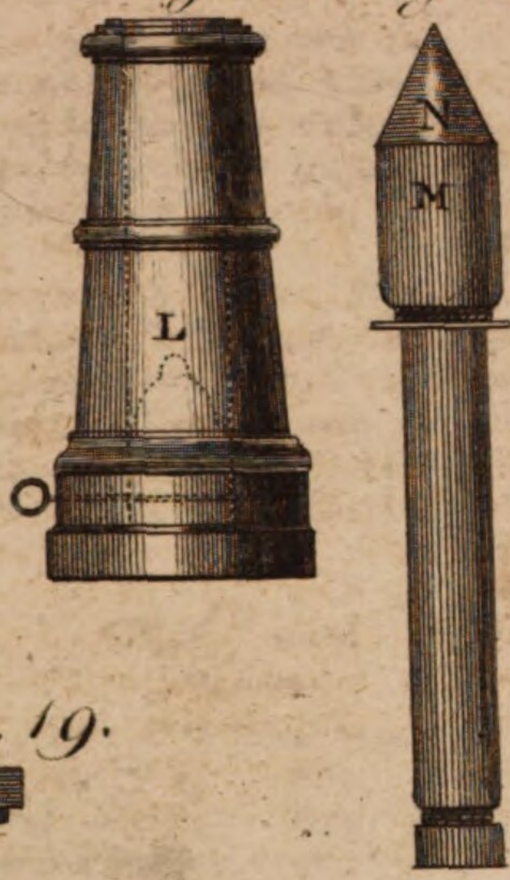


Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.

Fig. 18.

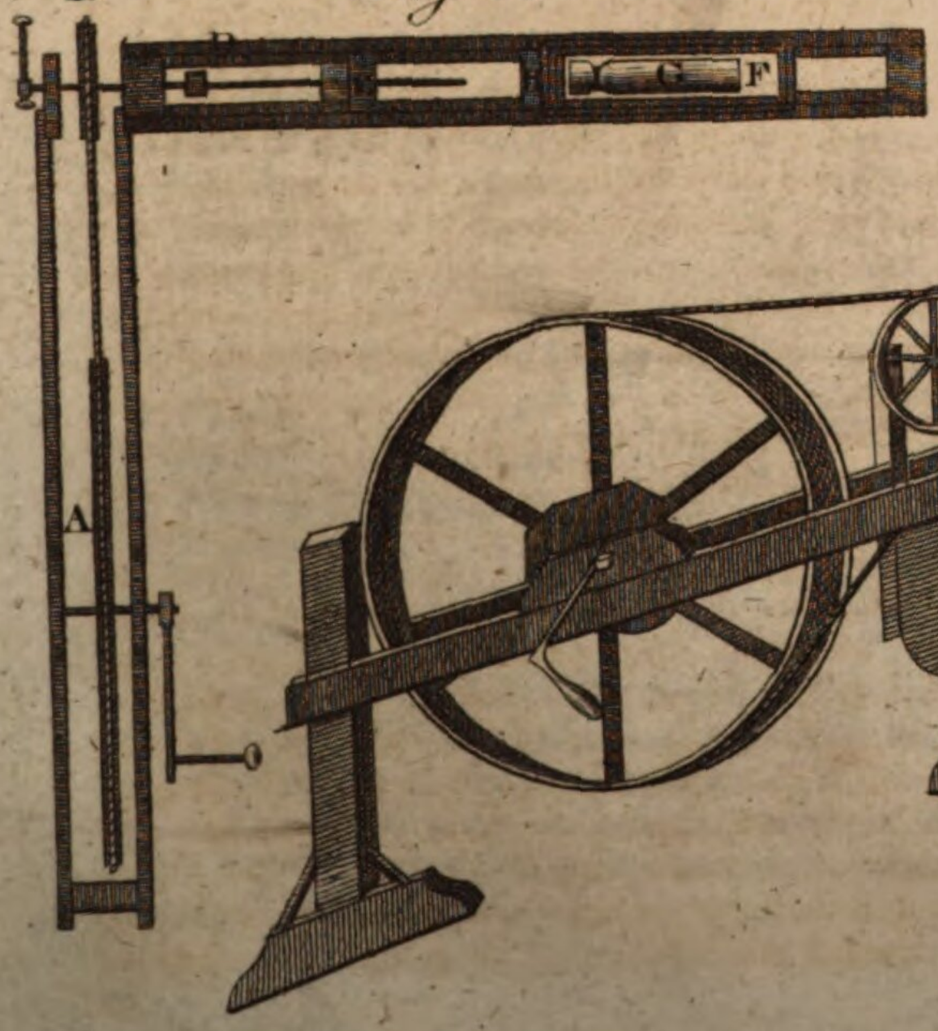


Fig. 19.

Fig. 20.

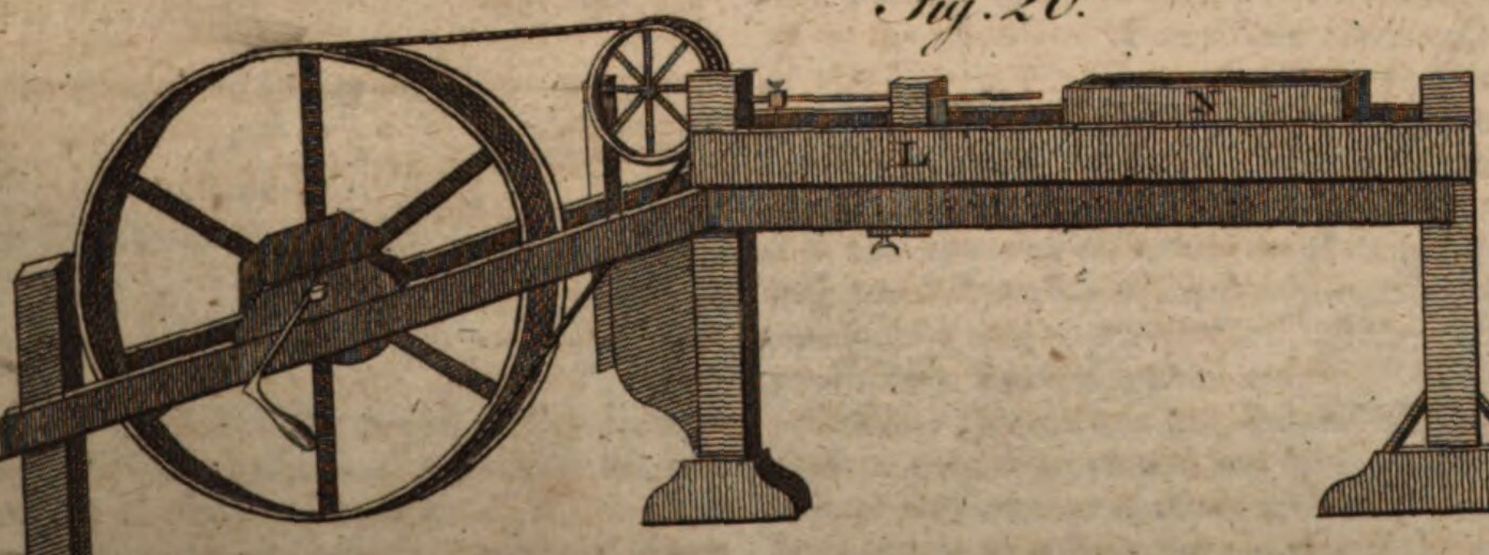


Fig. 23.

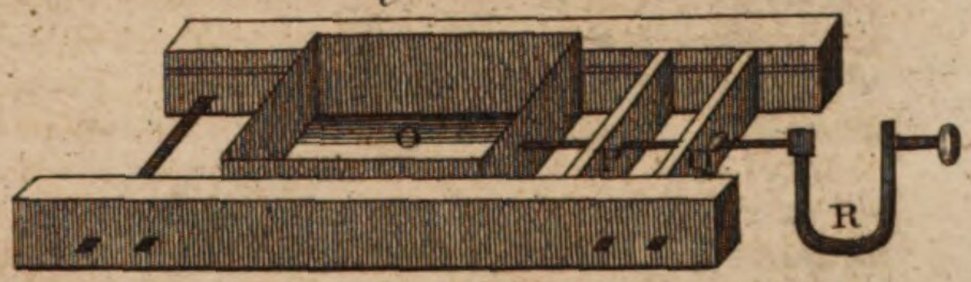
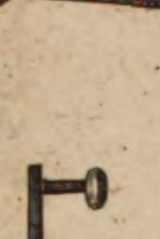


Fig. 21.

Fig. 22



A Bell. Prin. Wat. Sculptor fecit.

Pyramid. to a well, which is on the left, and goes to the very foundations of the pyramid. Pliny makes mention of this well, and ſays it is 26 cubits deep. The internal air of this edifice never being renewed, is ſo hot and mephitic that one is almoſt ſuffocated. When we came out of it, we were dropping with ſweat, and pale as death. After refreſhing ourſelves with the external air, we loſt no time in aſcending the pyramid. It is compoſed of more than 200 layers of ſtone. They overlap each other in proportion to their elevation, which is from two to four feet. It is neceſſary to climb up all theſe enormous ſteps to reach the top. We undertook it at the north-eaſt angle, which is the leaſt damaged. It took us, however, half an hour with great pains and many efforts to effect it.

"The ſun was riſing, and we enjoyed a pure air, with a moſt delicious coolneſs. After admiring the proſpect around us, and engraving our names on the ſummit of the pyramid, we deſcended cautiouſly, for we had the abyſs before us. A piece of ſtone detaching itſelf under our feet or hands might have ſent us to the bottom.

"Arrived at the foot of the pyramid, we made the tour of it, contemplating it with a ſort of horror. When viewed cloſe, it ſeems to be made of maſſes of rocks; but at a hundred paces diſtance, the largeneſs of the ſtones is loſt in the immenſity of the whole, and they appear very ſmall.

"To determine its dimenſions is ſtill a problem. From the time of Herodotus to our days it has been meaſured by a great number of travellers and learned men, and their different calculations, far from clearing up doubts, have only increaſed the uncertainty. The following table will ſerve at leaſt to prove how difficult it is to come at the truth.

Height of the great Pyramid.	*Width of one of its ſides.*
Ancients.	French Feet.
Herodotus - 800	- - 800
Strabo - 625	- - 600
Diodorus Siculus 600 and a fraction.	700
Pliny - - - - -	708
Moderns.	
Le Bruyn - 616	- - 704
Proſper Alpinus 625	- - 750
Thevenot - 520	- - 682
Niebuhr - 440	- - 710
Greaves - 444	- - 648

Number of layers of Stone which form it.

Greaves -	207	- - layers.
Maillet -	208	
Albert Liewenſtein	260	
Pococke -	212	
Belon -	250	
Thevenot -	208	

"It appears that Meſſrs Greaves and Niebuhr have prodigiouſly deceived themſelves in meaſuring the perpendicular height of the great pyramid. All the travellers allow that it has at leaſt 200 layers of ſtone. Theſe layers are from two to four feet high. According to Pococke, they are from four feet and a half to four feet high, being not ſo high at the top as at the baſe. Proſper Alpinus informs us, that the elevation of the firſt layer is five feet, but it diminiſhes inſenſibly in proportion as one mounts. Thevenot mentions 208 ſteps of large ſtones, the thickneſs of which makes the height of them about two feet and a half one with another: He meaſured ſome of them more than three feet high. I have meaſured ſeveral of them which were more than three feet high, and I found none leſs than two; the leaſt height of them we can take as a medium therefore is two feet and a half, which, even according to Mr Greaves's calculation, who reckons 207 layers, would make 517 feet 6 inches perpendicular height. Meſſrs Greaves, Maillet, Thevenot, and Pococke, who only differ in the number of the layers from 207 to 212, all mounted by the north-eaſt angle, as the leaſt injured. I followed the ſame route, and counted only 208 ſteps. But if we reflect that the pyramid has been open on the ſide next the deſert, that the ſtones on that ſide have been thrown down, that the ſand which covers them has formed a conſiderable hill, we ſhall not be aſtoniſhed that Albert Liewenſtein, Belon, and Proſper Alpinus, who muſt have mounted by the ſouth-eaſt or ſouth-weſt angle, which are leſs expoſed to the ſands of Lybia, ſhould have found a greater number of ſteps: ſo that the calculation of theſe travellers, agreeing with that of Diodorus Siculus and Strabo, appears to be neareſt the true height of the pyramid taken at its natural baſe; whence we may conclude with reaſon that it is at leaſt 600 feet high. Indeed this is authenticated by a paſſage of Strabo. Theſe are his words: 'Towards the middle of the height of one of the ſides is a ſtone that may be raiſed up. It ſhuts an oblique paſſage which leads to a coffin placed in the centre of the pyramid.' This paſſage, open in our days, and which in the time of Strabo was towards the middle of one face of the pyramid, is at preſent only 100 feet from the baſe. So that the ruins of the covering of the pyramid, and of the ſtones brought from within, buried by the ſand, have formed a hill in this place 200 feet high. Pliny confirms this opinion. The great ſphynx was in his time upwards of 62 feet above the ſurface of the ground. Its whole body is at preſent buried under the ſand. Nothing more appears of it than the neck and head, which are 27 feet high. If even the ſphynx, though defended by the pyramids againſt the northerly winds, which bring torrents of ſand from Libya, be covered as high as 38 feet, what an immenſe quantity muſt have been heaped up to the northward of an edifice whoſe baſe is upwards of 700 feet long? It is to this we muſt attribute the prodigious difference between the accounts of the hiſtorians who have meaſured the great pyramid at diſtant periods, and at oppoſite angles. Herodotus, who ſaw it in the age neareſt to its foundation, when its true baſe was ſtill uncovered, makes it 800 feet ſquare. This opinion appears very probable. Pliny alſo ſays that it covered the ſpace of eight acres.

Pyramid.

"Meſſrs Shaw, Thevenot, and the other travellers who pretend that this pyramid was never finiſhed, becauſe it is open and without coating, are in an error. It is only neceſſary to obſerve the remains of the mortar, with the ſplinters of white marble which are to be found in many

Pyramid.

many parts of the ſteps, to ſee that it has been coated. After reading attentively the deſcription given of it by the ancients, every doubt vaniſhes, and the truth is as clear as day-light. Herodotus tells us, 'The great pyramid was covered with poliſhed ſtones, perfectly well jointed, the ſmalleſt of which was 30 feet long. It was built in the form of ſteps, on each of which were placed wooden machines to raiſe the ſtones from one to another.' According to Diodorus, 'The great pyramid is built of ſtones, very difficult of workmanſhip, but of an eternal duration. It is preſerved to our days (towards the middle of the Auguſtan age) without being in the leaſt injured. The marble was brought from the quarries of Arabia.' This hiſtorian thought that the whole building was compoſed of ſtones, ſimilar to thoſe of the coating, which were of very hard marble. Had there been ſome pieces torn off, he would have perceived under that covering a calcareous ſtone rather ſoft. Pliny ſays that it 'is formed of ſtones brought from the quarries of Arabia. It is not far from the village of Buſiris (which ſtill exiſts under the name of *Bouſir*), where thoſe perſons reſide who are ſo ſkilful as to climb up to the top.'

"This paſſage ſhows that Pliny, deceived by the appearance, was in the ſame error with Diodorus Siculus. It demonſtrates alſo that it was covered: for what difficulty would there have been for the inhabitants of Buſiris to ſcale a building raiſed by ſteps? but it was really a prodigy for them to get up it when it formed a mountain, the four inclined planes of which preſented a ſurface covered with poliſhed marble. It is indeed an inconteſtable fact, that the great pyramid was coated. It is as certain too that it has been ſhut, as Strabo gives us to underſtand; and that by removing a ſtone placed in the middle of one of the ſides, one found a paſſage which led to the tomb of the king. But I ſhall leave Mr Maillet, who viſited it 40 times with all imaginable attention, the honour of relating the means employed to open it. I have examined the inſide of it in two different journeys: twice I have mounted it: and I cannot help admiring the ſagacity with which that author has developed the mechaniſm of that aſtoniſhing edifice."

Our author next proceeds to give a particular deſcription of the methods by which it is moſt probable that the pyramids were cloſed, and the immenſe labour requiſite to open them; but as this deſcription affords nothing very intereſting, we ſhall not inſert it. Only we muſt remark, that the final outlet to the workmen he ſuppoſes to have been the well at the entrance formerly mentioned. This well deſcends towards the bottom of the pyramid by a line not quite perpendicular to the horizon, but ſlanting a little, in ſuch a manner as to reſemble the figure of the Hebrew letter Lamed. About 60 feet from the aperture there is a ſquare window in this paſſage, from whence we enter a ſmall grotto hewn out of the mountain; which in this place is not a ſolid ſtone, but a kind of gravel concreted together. The grotto extends about 15 feet from eaſt to weſt, where there is another groove hollowed likewiſe, but almoſt perpendicular. It is two feet four inches wide by two and an half in height. It deſcends through a ſpace of 123 feet, after which we meet with nothing but ſand and ſtones. M. Savary is convinced that the only uſe of this paſſage was to ſerve as a retreat for the labourers who conſtructed the pyramid; and of this he looks upon the ſlope of the conduit, its winding road, its ſmallneſs, and its depth, to be certain proofs. The way out of it he ſuppoſes to have been formed by a paſſage over which hung a row of ſtones, which they had diſcovered the ſecret of ſuſpending, and which falling down into the paſſage by the means of ſome ſpring they ſet in motion, ſhut up the entrance for ever, as ſoon as the workmen were withdrawn from the pyramid. Pyramid.

It ſeems to be an unqueſtionable fact, that this pyramid was a mauſoleum of one of the kings of Egypt, and it is very probable that all the reſt anſwered ſimilar purpoſes. We do not, however, think that this was their primary uſe or the original deſign of their builders. Mr Bryant is of opinion that they were temples erected in honour of the Deity; and a very ingenious writer in the Gentleman's Magazine for June 1794 has done much to prove that they were altars dedicated to the ſun, the firſt and greateſt god in every pagan kalendar.

"Our Engliſh word pyramid (ſays he) is directly derived from the Latin *pyramis*, and mediately from the Greek πυραμις; all denoting the ſame mathematical figure. The original of the whole ſeems to be the Egyptian word *pyramoua*, which, we are told by Oriental ſcholars, ſignifies light, or a ray of light. From this Coptic vocable the word πυρ in Greek, ſignifying fire, is probably deſcended; as the flames of fire aſſume that conical or pyramidal form which the ſolar rays commonly diſplay; and as it is natural for the mind to diſtinguiſh its objects rather by their external qualities, and thoſe obvious and intereſting appearances which they exhibit to the ſenſes, than by their conſtituent and inſeparable properties.

"The ancient Egyptians ſeem to have penetrated very far into the myſteries of nature; and although their ſuperſtition appears at firſt ſight to be extremely groſs and abſurd, yet it is very probable that their deities were only emblematical perſonages, repreſenting by ſenſible images the grand effects or preſiding principles which they ſuppoſed to exiſt in the univerſe. Thus the moon was called *Iſis*, and the ſun *Oſiris*; and to the honour of this laſt deity, from whoſe viſible influence and creative energy all things ſeem to ſpring into exiſtence, it is not improbable that the Egyptians erected thoſe ſtupendous monuments, and dedicated them to him as temples or altars. It was natural to build them in that ſhape which the rays of the ſun diſplay when diſcovered to the eye, and which they obſerved to be the ſame in terreſtrial flame, becauſe this circumſtance was combined in their imaginations with the attribute which they adored. If they were temples dedicated to the ſun, it ſeems a natural conſequence that they ſhould likewiſe be places of ſepulture for kings and illuſtrious men, as the ſpace which they covered would be conſidered as conſecrated ground. This hypotheſis is common, and is not contradicted by the preſent reaſoning. But, conſidering them as altars, and as moſt travellers agree that they were never finiſhed, but terminate in a ſquare horizontal ſurface, it would not be refining too much to venture an aſſertion that, in great and ſolemn acts of adoration, the Egyptians conſtructed fires, the flames of which ſhould terminate in the vertex of the pyramid, and ſo complete that emanation of their deity which they admired and adored. As far, therefore, as we are juſtified in forming any concluſion on ſo dark a ſubject, we

Pyramid. we may venture to say, that the Egyptian pyramids were temples or altars dedicated to the sun, as the material representative of that invisible power which creates, governs, and pervades, the whole system of nature."

This reasoning has great force; and it certainly receives additional strength from the undoubted fact, that the first statues for idolatrous worship were erected on the tops of mountains, and of a pyramidal or conical form. (See POLYTHEISM, n° 13 and 21.) It is likewise corroborated by other circumstances discovered by the members of the Asiatic Society. In the second volume of their transactions we have an account of several large statues of the gods SEEVA and MCHEDEO, all of a conical or pyramidal figure; but it has been shown in the article already referred to, that the idolatry of Hindostan was probably of Egyptian original.

It is not known in Europe when the pyramids were built; but we have reason to expect a history of them soon from Shanscrit records examined by Mr Wilford lieutenant of engineers. It is as little known at what time, or from what motive, the great pyramid was opened. Some think it was done by one of the khalifs about the beginning of the eighth century, in expectation of finding a great treasure; but all he met with was the king's body, with some golden idols which had been buried along with it.—By others it is supposed to have been done by the celebrated Harun Al Basakid khalif of Bagdad; but all are agreed that this pyramid was opened in the time of the Arabs. The second pyramid has likewise been opened; and an attempt was made not long ago upon the third by one of the Beys of Cairo: but after removing a number of stones at a considerable expence, he thought proper to desist from the enterprize.—Mr Bryant is of opinion that the pyramids, at least the three great ones, are not artificial structures of stone and mortar, but solid rocks cut into a pyramidal shape, and afterwards cased with stone; and to this we find that Mr Bruce likewise assents. The reason given for this opinion is, that the passages within it seem rather to answer to the natural cavities and rents in rocks than to the artificial ones in buildings. The opinion, however, we think sufficiently confuted by Savary and Maillet: and, as an acute critic observes, it is in itself as improbable as that the caverns inhabited by the *Troglodytes* were dug by the hands of man. See TROGLODYTES.

On the east side of the second pyramid is the sphynx, an enormous mass of one solid stone, but so buried in the sand that only the top of the back is visible, which is 100 feet long. Its head rises, as we have seen, 27 feet above the sand; and its face has been disfigured by the Arabs, who hold all representations of men and living animals in detestation. Other travellers say that this sphynx is a huge mishapen rock, by no means worthy of the attention which has been bestowed upon it.

In the desert of Saccara there are a great number of pyramids, which, in Mr Bruce's opinion, are composed of clay. They terminate in what the inhabitants call a *dagiour*, or *false pyramid*, about two miles from the Nile, between Suf and Woodan. This is no other than a hill cut into the shape of a pyramid, or naturally so formed, for a considerable height; on the top of which is a pyramidal building of brick terminating in a point, and having its basis so exactly adapted to the top of the hill, that at a distance the difference cannot be perceived; especially as the face of the stone resembles very nearly the clay of which the pyramids of the Saccara are composed.

Pyramidales || Pyrometer.

PYRAMIDALES, in anatomy, one of the muscles of the abdomen. See ANATOMY, *Table of the Muscles*.

PYRENEAN MOUNTAINS, or PYRENEES, are the mountains which divide France from Spain, and are the most celebrated in Europe, except the Alps. They reach from the Mediterranean Sea as far as the ocean, and are about 212 miles in length. They have different names, according to the different places wherein they stand. Some think they are as high as the Alps; but the passages over them are not so difficult, whatever some travellers may think who have not crossed the former.

BANKSIA PYRIFORMIS, in botany, is a species of BANKSIA, which see. It was unknown to Linnæus; and Gaertner, who has mentioned it, gives no specific character of it. It has solitary flowers, ovate downy capsules, and lance-shaped entire smooth leaves. The capsules larger than in any other known species. See *White's Journal of a Voyage to New South Wales*, p. 221—225.

PYRITES, a genus of inflammable substances composed of sulphur, which has dissolved or saturated itself with metals. Thus there are many kinds of pyrites; as of gold, arsenic, iron, &c. It is also the principal ore of sulphur; particularly that called *martial pyrites*, *copperas-stone*, or *marcasite*. This is very common, containing a quantity of sulphur in proportion to the iron; and, when thoroughly inflamed, burns by itself. It is either of a compact texture, steel-grained, coarse-grained, or crystallised. In this last form, it shoots mostly into cube and octohedral figures, though it is met with also in innumerable other forms.

The liver-coloured marcasite has an appearance between that of the preceding and the blue copper-ore. The iron predominates in this kind, so that it is less fit than the other for extracting sulphur from it, or for the smelting of copper-ores. It is formed of a compact texture, coarse-grained, and steel-grained. See CHEMISTRY, n° 619 and 654; MINERALOGY, p. 109; and METALLURGY, p. 429.

PYRMONT, a town of Lippe in Germany, in the circle of Westphalia, and capital of a country of the same name. It has a castle, kept by a governor, who is under the counts of Waldeck. At a small distance from hence there are mineral waters, which are much esteemed. The Protestants have here the free exercise of their religion. It is seated on the confines of the duchy of Brunswick, 40 miles south-west of Hanover. E. Long. 9. 0. N. Lat. 52. 0.

PYROLA, in botany: A genus of the monogynia order, belonging to the decandria class of plants; and in the natural method ranking under the 18th order, *Bicornes*. The calyx is quinquepartite; there are five petals; the capsule is quinquelocular, opening at the angles.

PYROMANCY, a kind of divination by means of fire. See DIVINATON, n° 6.

PYROMETER, an instrument for measuring the expansion of bodies by heat. See CHEMISTRY, n° 103. Muschenbroeck, who was the original inventor of this machine, has given a table of the expansion of the different metals in the same degree of heat. Having prepared cylindric rods of iron, steel, copper, brass, tin,

Pyrometer. and lead, he expoſed them firſt to a pyrometer with one flame in the middle; then with two flames; and ſucceſſively to one with three, four, and five flames. But previous to this trial, he took care to cool them equally, by expoſing them ſome time upon the ſame ſtone, when it began to freeze, and Fahrenheit's thermometer was at 32 degrees. The effects of which experiment are digeſted in the following table, where the degrees of expanſion are marked in parts equal to the $\frac{1}{1300}$ part of an inch.

Expanſion of	Iron.	Steel.	Copper.	Braſs.	Tin.	Lead.
By one flame	80	85	89	110	153	155
By two flames placed cloſe together.	117	123	115	220		274
By two flames $2\frac{1}{2}$ inches diſtant.	109	94	92	141	219	263
By three flames placed cloſe together.	142	168	193	275		
By four flames placed cloſe together.	211	270	270	361		
By five flames.	230	310	310	377		

It is to be obſerved of tin, that it will eaſily melt when heated by two flames placed together. Lead commonly melts with three flames placed together, eſpecially if they burn long.

From theſe experiments, it appears at firſt view that iron is the leaſt rarefied of any of theſe metals, whether it be heated by one or more flames; and therefore is moſt proper for making machines or inſtruments which we would have free from any alterations by heat or cold, as the rods of pendulums for clocks, &c. So likewiſe the meaſures of yards or feet ſhould be made of iron, that their length may be as nearly as poſſible the ſame ſummer and winter.

The expanſion of lead and tin, by only one flame, is nearly the ſame; that is, almoſt double of the expanſion of iron. It is likewiſe obſervable, that the flames placed together, cauſe a greater rarefaction than when they have a ſenſible interval between them; iron in the former caſe, being expanded 117 degrees, and only 109 in the latter; the reaſon of which difference is obvious.

By comparing the expanſions of the ſame metal produced by one, two, three, or more flames, it appears that two flames do not cauſe double the expanſion of one, nor three flames three times that expanſion, but always leſs; and theſe expanſions differ ſo much the more from the ratio of the number of flames as there are more flames acting at the ſame time.

It is alſo obſervable, that metals are not expanded equally at the time of their melting, but ſome more ſome leſs. Thus tin began to run when rarefied 219 degrees; whereas braſs was expanded 377 degrees, and yet was far from melting.

Pyrometer. Mr Ellicot found, upon a medium, that the expanſion of bars of different metals, as nearly of the ſame dimenſions as poſſible, by the ſame degree of heat, were as follow:

Gold,	Silver,	Braſs,	Copper,	Iron,	Steel,	Lead,
73	103	95	89	60	56	149

The great difference between the expanſions of iron and braſs has been applied with good ſucceſs to remedy the irregularities in pendulums ariſing from heat. See PENDULUM.

Mr Graham uſed to meaſure the minute alterations, in length, of metal bars, by advancing the point of a micrometer-ſcrew, till it ſenſibly ſtopped againſt the end of the bar to be meaſured. This ſcrew, being ſmall and very lightly hung, was capable of agreement within the three or four-thouſandth part of an inch. On this general principle Mr Smeaton contrived his pyrometer, in which the meaſures are determined by the contact of a piece of metal with the point of a micrometer-ſcrew.

The following table ſhows how much a foot in length of each metal grows longer by an increaſe of heat, correſponding to 180° of Fahrenheit's thermometer, or to the difference between freezing and boiling water, expreſſed in ſuch parts of which the unit is equal to the 10,000th part of an inch.

1.	White-glaſs barometer tube,	100
2.	Martial regulus of antimony,	130
3.	Bliſtered ſteel,	138
4.	Hard ſteel,	147
5.	Iron,	151
6.	Biſmuth,	167
7.	Copper hammered,	204
8.	Copper eight parts, with tin one,	218
9.	Caſt braſs,	225
10.	Braſs ſixteen parts, with tin one,	229
11.	Braſs-wire,	232
12.	Speculum metal,	232
13.	Spelter ſolder, viz. braſs two parts, zinc one,	247
14.	Fine pewter,	274
15.	Grain tin,	298
16.	Soft ſolder, viz. lead two, tin one,	301
17.	Zinc eight parts, with tin one, a little hammered,	323
18.	Lead,	344
19.	Zinc or ſpelter,	353
20.	Zinc hammered half an inch per foot,	373

We ſhall cloſe this article with a brief deſcription of a pyrometer lately invented by M. De Luc, in conſequence of a hint ſuggeſted to him by Mr Ramſden. The baſis of this inſtrument is a rectangular piece of deal-board two feet and a half long, 15 inches broad, and one inch and a half thick; and to this all the other parts are fixed. This is mounted in the manner of a table, with four deal legs, each a foot long and an inch and a half ſquare, well fitted near its four angles, and kept together at the other ends by four firm croſs-pieces. This ſmall table is ſuſpended by a hook to a ſtand; the board being in a vertical ſituation in the direction of its grain, and bearing its legs forward in ſuch a manner as that the croſs-pieces which join them may form a frame, placed vertically facing the obſerver. This frame ſuſtains a microſcope, which is firmly fixed in another frame that moves in the former by means of grooves, but with a very conſiderable degree of tightneſs;

Pyrometer, Pyrophorus.

neſs; the friction of which may be increaſed by the preſſure of four ſcrews. The inner ſliding frame, which is likewiſe of deal, keeps the tube of the microſcope in a horizontal poſition, and in great part without the frame, inſomuch that the end which carries the lens is but little within the ſpace between the frame and the board. This microſcope is conſtructed in ſuch a manner as that the object obſerved may be an inch diſtant from the lens; and it has a wire which is ſituated in the focus of the glaſſes, in which the objects appear reverſed. At the top of the apparatus there is a piece of deal, an inch and a half thick and two inches broad, laid in a horizontal direction from the board to the top of the frame. To this piece the rods of the different ſubſtances, whoſe expanſion by heat is to be meaſured, are ſuſpended: one end of it ſlides into a ſocket, which is cut in the thickneſs of the board; and the other end, which reſts upon the frame, meets there with a ſcrew, which makes the piece move backward and forward, to bring the objects to the focus of the microſcope. There is a cork very ſtrongly driven through a hole boared vertically through this piece; and in another vertical hole made through the cork, the rods are fixed at the top; ſo that they hang only, and their dilatation is not counteracted by any preſſure. In order to heat the rods, a cylindrical bottle of thin glaſs, about 21 inches high, and four inches in diameter, is placed in the inſide of the machine, upon a ſtand independent of the reſt of the apparatus. In this bottle the rods are ſuſpended at a little leſs than an inch diſtance from one of the inſides, in order to have them near the microſcope. Into this bottle is poured water of different degrees of heat, which muſt be ſtirred about, by moving upwards and downwards, at one of the ſides of the bottle, a little piece of wood, faſtened horizontally at the end of a ſtick: in this water is hung a thermometer, the ball of which reaches to the middle of the height of the rods. During theſe operations the water riſes to the cork, which thus determines the length of the heated part; the bottle is covered, to prevent the water from cooling too rapidily at the ſurface; and a thin caſe of braſs prevents the vapour from fixing upon the piece of deal to which the rods are fixed.

PYROPHORUS, formed of πυρ, *fire*, and φερω, *I bear*, in chemiſtry, the name uſually given to that ſubſtance called by ſome black phoſphorus; a chemical preparation poſſeſſing the ſingular property of kindling ſpontaneouſly when expoſed to the air. See CHEMISTRY, n° 1414.

This ſubſtance was accidentally diſcovered by M. Homberg, who prepared it of alum and human fæces. See PHOSPHORUS. It was apprehended, for a conſiderable time after the diſcovery, that human fæces were eſſential to the operation, till the youngeſt ſon of the great Lemeri found that honey, ſugar, flour, and indeed any animal or vegetable matter, might be ſubſtituted inſtead of the human fæces; and ſince that time, M. De Sauvigny has ſhown that moſt vitriolic ſalts may be ſubſtituted for the alum; having added to the aluminous pyrophorus of Homberg two other claſſes of ſubſtances of this kind, viz. the metallic, or thoſe made with the three vitriols of iron, copper, and zinc; and the neutral, or thoſe compoſed of vitriolated tartar and Glauber's ſalt.

Pyrophorus.

Mr Bewly prepares his pyrophorus in the following manner. "I fill (ſays he) half or three-fourths of the bowl of a tobacco-pipe with a mixture, conſiſting of two parts of alum, previouſly calcined in a red-heat, and of powdered charcoal and ſalt of tartar each one part; preſſing the matter down ſlightly, and filling the remainder of the bowl with fine ſand. As ſoon as the powder becomes hot, the ſand lying over it is put into a ſtate of ebullition, which generally continues ſeveral minutes. This appearance ſeems to proceed partly from the vitriolic acid in the alum leaving its earth, and expelling fixed air from the alkali; while another part of it is poſſibly converted into vitriolic acid air. This phenomenon is ſucceeded by the appearance of a blue ſulphureous flame, proceeding from the combination of the ſame acid with what was formerly called the *phlogiſton of the coal*, and which continues about ten minutes or a quarter of an hour. After it ceaſes, no other remarkable appearance preſents itſelf. The matter is now to be kept in a red heat 20 minutes or half an hour; or it may continue there two hours longer, if the operator pleaſes, without any injury to the pyrophorus. The pipe being taken out of the fire, the matter is knocked out of it as ſoon as it becomes cool, and generally pretty ſoon afterwards takes fire ſpontaneouſly."

In another experiment, having added ſucceſſively various and increaſing quantities of fixed alkali to the ſalt heated as above, till the vitriolic acid contained in the mixture might be conſidered merely as an evaneſcent quantity, a pyrophorus was ſtill produced on calcining it with charcoal as before. He alſo mixed equal parts of ſalt of tartar and vegetable or animal coal, or ſometimes three parts of the former with two of the latter, and calcined them in the uſual manner: and this compoſition, on being expoſed to the air, generally kindled in half a minute or a minute; though, as it contained no ſulphur, it did not burn with ſo much vivacity as the vitriolic pyrophori. This, which Mr Bewly calls the *alkaline pyrophorus*, differs in no circumſtance from M. De Sauvigny's neutral pyrophori, except in its not containing that principle to which he aſcribes their accenſion. However, leſt it might be ſuſpected that the ſalt of tartar which he employed might accidentally contain vitriolated tartar, or vitriolic acid, he repeated the experiment with tartar calcined by himſelf, as well as with nitre fixed or alkaliſed by deflagration with charcoal, and with iron filings; and in all theſe caſes with the ſame reſult. By diverſifying in a like manner M. De Sauvigny's experiments on the metallic pyrophori, Mr Bewly found that none of the three vitriols, heated with charcoal alone, in his uſual method, could produce a pyrophorus. And thus he found that the addition of an alkaline ſalt to the compoſition, which was a part of M. De Sauvigny's proceſs, was eſſential to its ſucceſs.

Treating in the uſual manner equal parts of calcined green vitriol and charcoal, the powder, which contained no ſulphur nor hepar ſulphuris, did not acquire any of the properties of a pyrophorus. The vitriolic acid ſeemed to have been entirely diſſipated, having no baſe to detain it, when diſlodged from the metallic earth. The charcoal and calx of iron left in this proceſs were calcined again, together with ſome ſalt of tartar: and a pyrophorus was produced, which exhibited indications of its containing a ſcarce perceptible

Pyrophorus.

portion of hepar ſulphuris. Thirty grains of crocus martis aſtringens were calcined with 15 grains of charcoal, and the ſame quantity of ſalt of tartar; and the mixture burnt ſpontaneouſly, though it contained no hepar ſulphuris or vitriolic acid. Having by theſe experiments evinced that metallic pyrophori may be prepared without vitriolic acid, Mr Bewly proceeded to form an aluminous pyrophorus of the ſame kind. For this purpoſe he procured the earth of alum by a long and violent calcination; and examining a part of it, he found, by the uſual teſts, that it neither contained any ſulphur, hepar ſulphuris, nor alum undecompounded. This he conſidered as perfectly pure, though he afterwards found that it contained a ſmall quantity of vitriolated tartar; and yet it repeatedly furniſhed a pyrophorus, as active as when alum itſelf is employed. From theſe and ſimilar experiments, he infers, that the ſeveral kinds of pyrophori are not kindled by moiſture, attracted by the vitriolic acid, as M. De Sauvigny has maintained: and his concluſion is farther confirmed by ſome experiments of Dr Prieſtley; from which it appears, that they are kindled in dry, nitrous, and what he calls dephlogiſticated air.

M. Prouſt, cited by Mr Bewly, deſcribes a variety of new pyrophori, which neither contain vitriolic acid, nor ſeem likely to owe their accenſion to the attraction of humidity from the air. Theſe principally conſiſt of a coaly matter ſimply divided by metallic or other earths; ſuch are the ſediment left on the filter in preparing Goulard's extract, various combinations of tartar or its acid, or the acetous acid, with metals, calcareous earth, &c.

Mr Bewly, having evinced the inſufficiency of M. De Sauvigny's theory, and diſcovered that the pyrophori are not kindled by moiſture, attracted (merely) by the vitriolic acid, directed his attention to the nitrous acid, which Dr Prieſtley has ſhown to be a conſtituent part of atmoſpherical air, as the probable agent in the production of this phenomenon. The ſtrong affinity which this acid has with phlogiſton, and the heat, and even flame, which it is known to produce with certain inflammable matters, manifeſted that it was equal to the effect; and having excluded the vitriolic acid from having any eſſential concern in this operation, he ſuggeſts, either that the pyrophorus is kindled by moiſture attracted by ſome of the other ingredients which compoſe it; or that it has the power of decompounding atmoſpherical air, by ſuddenly attracting its nitrous acid, and thereby generating a heat ſufficient to kindle the phlogiſtic matter contained in it. This idea appeared plauſible, when he farther conſidered that Dr Prieſtley produced the pureſt reſpirable air with this ſame acid combined with other principles; and that this as well as common air is diminiſhed, and probably in part decompounded, in a variety of phlogiſtic proceſſes. This ingenious writer concludes, upon the whole, from the experiments he hath made, that the pyrophorus ſeems to owe its ſingular property to its being a combination of earth or alkali with phlogiſton; the vitriolic acid, when preſent, only occaſionally increaſing or diminiſhing the effect, according to circumſtances. In the proceſs of calcination, the earth or alkaline principle is not merely mixed, but actually, though looſely, combined with the phlogiſtic principle of the coal; ſo that the pyrophorus, conſidering it in its moſt ſimple ſtate, is only a perfectly dry phlogiſticated alkali or earth. On theſe data, the phenomena may be explained in the two following methods; with reſpect particularly to the influence of moiſture and heat upon the pyrophorus. Suppoſing either the alkaline or earthy principle to have a greater affinity to water than to the phlogiſton with which either of them is united, they may, on being expoſed to a moiſt atmoſphere, attract the humidity, and thereby ſet the phlogiſtic principle at liberty; which may, in its turn, attract, and be ignited by, the ſuppoſed aerial acid; its ſtrong affinity to which is well known:—or, if this hypotheſis be rejected, the inflammable matter may be kindled, merely in conſequence of the heat produced by the combination of the alkali, &c. with moiſture.

Mr Keir gives the following deſcription of a proceſs for preparing a new pyrophorus which he has lately diſcovered: "I filled about five-ſixths of the contents of a copper cylindrical box, which had a lid fitted to it, and which was three inches in diameter and two inches in depth, with ſaw-duſt, which I preſſed down; and I laid upon the ſaw-duſt as much well-waſhed *plumbum corneum* as entirely filled the box, which I then covered with its lid. I placed the box on the coals of a chamber-fire, ſo that its bottom only ſhould be in contact with the fuel, and I kept it on the fire till no more vapour ſeemed to iſſue at the joining of the lid. I then removed it from the fire; and while it was hot, I cloſed up the joining of the lid with ſealing-wax, by which means the external air was excluded. After it had ſtood in the cold about ten hours, I opened the box; and the corneous lead, which was very white before the operation, was now rendered black by the vapour which had ariſen from the ſaw-duſt, and which was obliged to paſs through the lead before it could eſcape. This black metallic maſs was no ſooner expoſed to the air, than ignited ſparks appeared, which ſpread more and more, while the lead was ſeen to revive in the form of minute globules, and the part which did not revive was changed into a yellow powder, or calx of lead. It is to be obſerved, that before I opened the box, I placed it at the ſide of the fire, in order to melt the ſealing-wax, to enable me to ſeparate the lid. It is poſſible that this ſmall degree of heat may be neceſſary, or conducive, to the accenſion. I ought alſo to acquaint you, that the preparation of this pyrophorus requires nicer attention than that of any which I am acquainted with. For a ſmall exceſs of heat will revive the lead, which will ſpoil the experiment. Alſo, if any air be admitted through the joints of the veſſels employed, the kindling property will be prevented by the abſorption of the air; which in this caſe is generally too gradual to produce inflammation. The metallic ſubſtance in this ſtate of impregnation with inflammable matter, although not a pyrophorus, is an exceeding quick tinder. For when touched, however ſlightly, by an ignited body, it will inſtantly kindle, and the fire will ſpread over the whole piece, reviving the lead wherever it goes, and exhibiting a very beautiful example of metallic reduction, not unlike the familiar experiment of reviving the lead of a wafer containing minium at the flame of a candle; but with this difference, that the fire in the wafer requires to be kept up by flame; whereas in this metallic tinder it ſpreads and creeps ſpontaneouſly along without flame over the maſs.

PYROTECHNY;

PYROTECHNY;

Ingredients and Compoſitions.

THE art of fire, or a ſcience which teaches the management and application of fire in ſeveral operations. See FIRE, FURNACE, CHEMISTRY, DISTILLATION, METALLURGY, &c.

But the term is more particularly uſed to denote the doctrine of artificial fire-works and fire-arms, teaching the ſtructure and uſe, 1. Of thoſe uſed in war, the attacking of fortifications, &c. for which ſee the articles FUSEE, GUN, GUNNERY, GUNPOWDER, MINE, &c.; and, 2. Of thoſe made for amuſement's ſake, as rockets, ſtars, ſerpents, &c. the preparation and conſtruction of which fall to be explained in the preſent article.

SECT. I. *Of Ingredients and Compoſitions.*

1. *Saltpetre.*

Captain Jones's Artificial Fire-works.

Saltpetre being the principal ingredient in fire-works, and a volatile body, by reaſon of its aqueous and aerial parts, is eaſily rarefied by fire; but not ſo ſoon when foul and groſs as when purified from its crude and earthy parts, which greatly retard its velocity: therefore, when any quantity of fire-works are to be made, it ſhould be examined; for if it is not well cleanſed, and of a good ſort, your works will not have their proper effect; neither will it agree with the ſtanding proportions of compoſitions. Therefore,

To refine it, put into a copper, or any other veſſel, 100 lb. of rough nitre with 14 gallons of clean water; let it boil gently half an hour, and as it boils take off the ſcum; then ſtir it, and before it ſettles put it into your filtering bags, which muſt be hung on a rack, with glazed earthen pans under them, in which muſt be ſticks laid acroſs for the cryſtals to adhere to: it muſt ſtand in the pans two or three days to ſhoot; then take out the cryſtals, and let them dry. The water that remains in the pans boil again an hour, and ſtrain it into the pans as before, and the ſaltpetre will be quite clear and tranſparent; if not, it wants more refining; to do which proceed as uſual, till it is well cleanſed of all its earthy parts.

N. B. Thoſe who do not chooſe to procure their ſaltpetre by the above method, may buy it ready done, which for fire-works in general will do.

To pulveriſe Saltpetre. Take a copper kettle, whoſe bottom muſt be ſpherical, and put into it 14 lb. of refined ſaltpetre, with 2 quarts or 5 pints of clean water: then put the kettle on a ſlow fire; and when the ſaltpetre is diſſolved, if any impurities ariſe, ſkim them off, and keep conſtantly ſtirring with two large ſpatulas, till all the water exhales; and when done enough, it will appear like white ſand, and as fine as flour; but if it ſhould boil too faſt, take the kettle off the fire, and ſet it on ſome wet ſand, which will prevent the nitre from ſticking to the kettle. When you have pulveriſed a quantity of ſaltpetre, be careful to keep it in a dry place.

To extract Saltpetre from damaged Gunpowder.—Have ſome filtering bags, hung on a rack, with glazed earthen pans under them, in the ſame manner as thoſe for refining ſaltpetre; then take any quantity of damaged powder, and put it into a copper, with as much clean water as will cover it: when it begins to boil, take off the ſcum; and after it has boiled a few minutes, ſtir it up: then take it out of the copper with a ſmall hand-kettle for that purpoſe, and put ſome into each bag, beginning at one end of the rack, ſo that by the time you have got to the laſt bag, the firſt will be ready for more. Continue thus till all the bags are full: then take the liquor out of the pans; which boil and filter, as before, two or three times, till the water run quite clear, which you muſt let ſtand in the pan ſome time, and the ſaltpetre will appear at top. To get the ſaltpetre entirely out of the powder, take the water from that already extracted, to which add ſome freſh and the dregs of the powder that remain in the bags, and put them in a veſſel, to ſtand as long as you pleaſe: and when you want to extract the nitre, you muſt proceed with this mixture as with the powder at firſt, by which means you will draw out all the ſaltpetre; but this proceſs muſt be boiled longer than the firſt.

2. *Sulphur, or Brimſtone.*

Sulphur is one of the principal ingredients in gunpowder, and almoſt in all compoſitions of fire-works; and therefore great care muſt be taken of its being good, and brought to the higheſt perfection. To know when ſulphur is good, you are to obſerve that it is of a high yellow; and if, when held in one's hand, it crackles and bounces, it is a ſign that it is freſh and good: but as the method of reducing brimſtone to a powder is very troubleſome, it is better to buy the flour ready made, which is done in large quantities, and in great perfection; though when a grand collection of fire-works are to be made, the ſtrongeſt and beſt ſulphur is the lump brimſtone ground in the manner directed in art. 8.

3. *Charcoal.*

Charcoal is a preſervative by which the ſaltpetre and the brimſtone are made into gunpowder, by preventing the ſulphur from ſuffocating the ſtrong and windy exhalation of the nitre. Charcoal for fire-works muſt always be ſoft and well burnt, which may be bought ready done.

4. *Gunpowder.*

See GUNPOWDER in the order of the alphabet. To grind or meal it, is directed in art. 8.

5. *Camphor.*

This may be had in the ſhops; and is of two kinds, differing in regard to the degree of their purity, and diſtinguiſhed by the name of *rough* and *refined*. Refined camphor muſt be choſen of a perfectly clean white colour, very bright and pellucid, of the ſame ſmell and taſte with the rough, but more acrid and pungent. It is ſo volatile, that merchants uſually incloſe it in lintſeed, that the viſcoſity of that grain may keep its particles together.

6. *Benjamin.*

This is a reſin found of different ſorts; and diſtinguiſhed by their colours, viz. yellow, grey, and brown; but the beſt is that which is eaſy to break, and full of

Ingredients and Compoſitions.

white ſpots. It is one of the ingredients in odoriferous fire-works, when reduced to a fine flour; which may be done by putting into a deep and narrow earthen pot 3 or 4 oz. of benjamin groſsly pounded; cover the pot with paper, which tie very cloſe round the edge; then ſet the pot on a ſlow fire, and once in an hour take off the paper, and you will find ſome flour ſticking to it, which return again in the pot; this you muſt continue till the flour appears white and fine. There is alſo an oil of benjamin, which is ſometimes drawn from the dregs of the flour; it affords a very good ſcent, and may be uſed in wet compoſitions.

7. *Spur-fire.*

This fire is the moſt beautiful and curious of any yet known; and was invented by the Chineſe, but now is in greater perfection in England than in China. As it requires great trouble to make it to perfection, it will be neceſſary that beginners ſhould have full inſtructions; therefore care ſhould be taken that all the ingredients are of the beſt, that the lamp-black is not damp and clodded, that the ſaltpetre and brimſtone are thoroughly refined. This compoſition is generally rammed in 1 or 2 oz. caſes about 5 or 6 inches long, but not drove very hard; and the caſes muſt have their concave ſtroke ſtruck very ſmooth, and the choak or vent not quite ſo large as the uſual proportion: this charge, when driven and kept a few months, will be much better than when rammed; and will not ſpoil, if kept dry, in many years.

As the beauty of this compoſition cannot be ſeen at ſo great a diſtance as brilliant fire, it has a better effect in a room than in the open air, and may be fired in a chamber without any danger: it is of ſo innocent a nature, that, though with an improper phraſe, it may be called a *cold fire;* and ſo extraordinary is the fire produced from this compoſition, that, if well made, the ſparks will not burn a handkerchief when held in the midſt of them; you may hold them in your hand while burning, with as much ſafety as a candle; and if you put your hand within a foot of the mouth of the caſe, you will feel the ſparks like drops of rain.—When any of theſe ſpur-fires are fired ſingly, they are called *artificial flower-pots*; but ſome of them placed round a tranſparent pyramid of paper, and fired in a large room, make a very pretty appearance.

The compoſition conſiſts of ſaltpetre 4 lb. 8 oz. ſulphur 2 lb. and lamp-black 1 lb. 8 oz.; or, ſaltpetre 1 lb. ſulphur $\frac{1}{2}$ lb. and lamp-black 4 quarts.—This compoſition is very difficult to mix. The ſaltpetre and brimſtone muſt be firſt ſifted together, and then put into a marble mortar, and the lamp-black with them, which you work down by degrees with a wooden peſtle, till all the ingredients appear of one colour, which will be ſomething greyiſh, but very near black: then drive a little into a caſe for trial, and fire it in a dark place; and if the ſparks, which are called *ſtars*, or *pinks*, come out in cluſters, and afterwards ſpread well without any other ſparks, it is a ſign of its being good, otherwiſe not; for if any droſſy ſparks appear, and the ſtars not full, it is then not mixed enough; but if the pinks are very ſmall, and ſoon break, it is a ſign that you have rubbed it too much.

This mixture, when rubbed too much, will be too fierce, and hardly ſhow any ſtars; and, on the contrary, when not mixed enough, will be too weak, and throw out an obſcure ſmoke, and lumps of droſs, without any ſtars. The reaſon of this charge being called the *ſpur-fire*, is becauſe the ſparks it yields have a great reſemblance to the rowel of a ſpur, from whence it takes its name.

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8. *To meal Gunpowder, Brimſtone, and Charcoal.*

There have been many methods uſed to grind theſe ingredients to a powder for fire-works, ſuch as large mortars and peſtles made of ebony and other hard wood, and horizontal mills with braſs barrels: but none have proved ſo effectual and ſpeedy as the laſt invention, that of the mealing-table, repreſented in fig. 1. made of elm, with a rim round its edge 4 or 5 inches high; and at the narrow end A, is a ſlider that runs in a groove, and forms part of the rim: ſo that when you have taken out of the table as much powder as you can with the copper ſhovel (fig. 2.) ſweep all clean out at the ſlider A. When you are going to meal a quantity of powder, obſerve not to put too much in the table at once; but when you have put in a good proportion, take the muller (fig. 3.) and rub it till all the grains are broke: then ſearce it in a lawn ſieve that has a receiver and top to it; and that which does not paſs through the ſieve, return again to the table, and grind it till you have brought it all fine enough to go through the ſieve. Brimſtone and charcoal are ground in the ſame manner, only the muller muſt be made of ebony; for theſe ingredients being harder than powder, would ſtick in the grain of elm, and be difficult to grind. As brimſtone is apt to ſtick and clod to the table, it will be beſt to keep one for that purpoſe, by which means you will always have your brimſtone clean and well ground.

Plate CCCCXXVIII

2d 8. *To make Wheels and other Works incombuſtible.*

It being neceſſary, when your works are new, to paint them of ſome dark colour; therefore, if, inſtead of which, you make uſe of the following compoſition, it will give them a good colour, and in a great meaſure prevent their taking fire ſo ſoon as if painted. Take brick-duſt, coal-aſhes, and iron-filings, of each an equal quantity, and mix them with a double ſize, made hot. With this waſh over your works, and when dry waſh them over again; this will preſerve the wood greatly againſt fire. Let the brick-duſt and aſhes be beat to a fine powder.

9. *To prepare Caſt-iron for Gerbes, white Fountains, and Chineſe Fire.*

Caſt iron being of ſo hard a nature as not to be cut by a file, we are obliged to reduce it into grains, though ſomewhat difficult to perform; but if we conſider what beautiful ſparks this ſort of iron yields, no pains ſhould be ſpared to granulate ſuch an eſſential material: to do which, get at an iron-foundery ſome thin pieces of iron, ſuch as generally run over the mould at the time of caſting: then have a ſquare block made of caſt iron, and an iron ſquare hammer about four lb. weight; then, having covered the floor with cloth or ſomething to catch the beatings, lay the thin pieces of iron on the block, and beat them with the hammer till reduced into ſmall grains; which afterwards ſearce with a very fine ſieve, to ſeparate the fine duſt, which is ſometimes uſed in ſmall caſes of brilliant fire, inſtead of ſteel duſt; and when you have got out all the duſt, ſift what remains with a ſieve a little larger, and ſo on with ſieves of different ſizes, till

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till the iron passes through about the bigness of small bird-shot: your iron thus beat and sifted, put each sort into wooden boxes or oiled paper, to keep it from rusting. When you use it, observe the difference of its size, in proportion to the cases for which the charge is intended; for the coarse sort is only designed for very large gerbes of 6 or 8 lb.

10. *Charges for Sky-rockets*, &c.

Rockets of four ounces. Mealed powder 1 lb. 4 oz. saltpetre 4 oz. and charcoal 2 oz.

Rockets of eight ounces. I. Mealed powder 1 lb. saltpetre 4 oz. brimstone 3 oz. and charcoal $1\frac{1}{2}$ oz. II. Meal-powder $1\frac{1}{2}$ lb. and charcoal $4\frac{1}{2}$ oz.

Rockets of one pound. Meal-powder 2 lb. saltpetre 8 oz. brimstone 4 oz. charcoal 2 oz. and steel-filings $1\frac{1}{2}$ oz.

Sky-rockets in general. I. Saltpetre 4 lb. brimstone 1 lb. and charcoal $1\frac{1}{2}$ lb. II. Saltpetre 4 lb. brimstone $1\frac{1}{2}$ lb. charcoal 1 lb. 12 oz. and meal-powder 2 oz.

Large sky-rockets. Saltpetre 4 lb. meal-powder 1 lb. and brimstone 1 lb.

Rockets of a middling size. I. Saltpetre 8 lb. sulphur 3 lb. meal-powder 3 lb. II. Saltpetre 3 lb. sulphur 2 lb. meal-powder 1 lb. charcoal 1 lb.

11. *For Rocket Stars.*

White Stars. Meal-powder 4 oz. saltpetre 12 oz. sulphur vivum 6 oz. oil of spike 2 oz. and camphor 5 oz.

Blue stars. Meal-powder 8 oz. saltpetre 4, sulphur 2, spirit of wine 2, and oil of spike 2.

Coloured or variegated stars. Meal-powder 8 drams, rochpetre 4 oz. sulphur vivum 2, and camphor 2.

Brilliant stars. Saltpetre $3\frac{1}{2}$ oz. sulphur $1\frac{1}{2}$, and meal-powder $\frac{1}{4}$, worked up with spirits of wine only.

Common stars. Saltpetre 1 lb. brimstone 4 oz. antimony $4\frac{1}{4}$, isinglass $\frac{1}{2}$, camphor $\frac{1}{2}$, and spirit of wine $\frac{3}{4}$.

Tailed stars. Meal-powder 3 oz. brimstone 2, saltpetre 1, and charcoal (coarsely ground) $\frac{3}{4}$.

Drove stars. I. Saltpetre 3 lb. sulphur 1 lb. brass dust 12 oz. antimony 3. II. Saltpetre 1 lb. antimony 4 oz. and sulphur 8.

Fixed pointed stars. Saltpetre $8\frac{1}{2}$ oz. sulphur 2, antimony 1 oz. 10 dr.

Stars of a fine colour. Sulphur 1 oz. meal-powder 1, saltpetre 1, camphor 4 dr. oil of turpentine 4 dr.

12. *Rains.*

Gold rain for sky-rockets. I. Saltpetre 1 lb. meal-powder 4 oz. sulphur 4, brass-dust 1, saw-dust $2\frac{1}{4}$, and glass-dust 6 dr. II. Meal-powder 12 oz. saltpetre 2, charcoal 4. III. Saltpetre 8 oz. brimstone 2, glass-dust 1, antimony $\frac{1}{4}$, brass-dust $\frac{1}{4}$, and saw-dust 12 dr.

Silver rain. I. Saltpetre 4 oz. sulphur, meal-powder, and antimony, of each 2 oz. sal prunella $\frac{1}{2}$ oz. II. Saltpetre $\frac{1}{2}$ lb. brimstone 2 oz. and charcoal 4. III. Saltpetre 1 lb. brimstone $\frac{1}{4}$ lb. antimony 6 oz. IV. Saltpetre 4 oz. brimstone 1, powder 2, and steel-dust $\frac{1}{4}$ oz.

13. *Water Rockets.*

I. Meal-powder 6 lb. saltpetre 4, brimstone 3, charcoal 5. II. Saltpetre 1 lb. brimstone $4\frac{1}{2}$ oz. charcoal 6. III. Saltpetre 1 lb. brimstone 4 oz. charcoal 12. IV. Saltpetre 4 lb. brimstone $1\frac{1}{2}$ lb. charcoal 1 lb. 12 oz. V. Brimstone 2 lb. saltpetre 4 lb. and meal-powder 4. VI. Saltpetre 1 lb. meal-powder 4 oz. brimstone $8\frac{1}{2}$, charcoal 2. VII. Meal-powder 1 lb. saltpetre 3, brimstone 1; sea-coal 1 oz. charcoal $8\frac{1}{2}$, saw-dust $\frac{1}{4}$, steel-dust $\frac{1}{2}$, and coarse charcoal $\frac{1}{4}$ oz. VIII. Meal-powder $1\frac{1}{4}$ lb. saltpetre 3, sulphur $1\frac{1}{2}$, charcoal 12 oz. saw-dust 2.

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Sinking charge for water-rockets. Meal-powder 8 oz. charcoal $\frac{1}{4}$ oz.

14. *Of Wheels.*

Wheel-cases from two ounces to four pounds. I. Meal-powder 2 lb. saltpetre 4 oz. iron-filings 7. II. Meal-powder 2 lb. saltpetre 12 oz. sulphur 4, steel-dust 3. III. Meal-powder 4 lb. saltpetre 1 lb. brimstone 8 oz. charcoal $4\frac{1}{2}$. IV. Meal-powder 8 oz. saltpetre 4, saw-dust $1\frac{1}{2}$, sea-coal $\frac{1}{4}$. V. Meal-powder 1 lb. 4 oz. brimstone 4 oz. 10 dr. saltpetre 8 oz. glass-dust $2\frac{1}{2}$. VI. Meal-powder 12 oz. charcoal 1, saw-dust $\frac{1}{2}$. VII. Saltpetre 1 lb. 9 oz. brimstone 4 oz. charcoal $4\frac{1}{2}$. VIII. Meal-powder 2 lb. saltpetre 1, brimstone $\frac{1}{2}$, and sea-coal 2 oz. IX. Saltpetre 2 lb. brimstone 1, meal-powder 4, and glass-dust 4 oz. X. Meal-powder 1 lb. saltpetre 2 oz. and steel-dust $3\frac{1}{2}$. XI. Meal-powder 2 lb. and steel-dust $2\frac{1}{4}$ oz. with $2\frac{1}{2}$ of the fine dust of beat iron. XII. Saltpetre 2 lb. 13 oz. brimstone 8 oz. and charcoal.

Slow fire for wheels. I. Saltpetre 4 oz. brimstone 2, and meal-powder $1\frac{1}{2}$. II. Saltpetre 4 oz. brimstone 1, and antimony 1 oz. 6 dr. III. Saltpetre $4\frac{1}{2}$ oz. brimstone 1 oz. and mealed powder $1\frac{1}{2}$.

Dead fire for wheels. I. Saltpetre $1\frac{1}{4}$ oz. brimstone $\frac{1}{4}$, lapis-calaminaris $\frac{1}{4}$, and antimony 2 dr.

15. *Standing or fixed Cases.*

I. Meal-powder 4 lb. saltpetre 2, brimstone and charcoal 1. II. Meal-powder 2 lb. saltpetre 1, and steel-dust 8 oz. III. Meal-powder 1 lb. 4 oz. and charcoal 4 oz. IV. Meal-powder 1 lb. and steel-dust 4 oz. V. Meal-powder $2\frac{1}{2}$ lb. brimstone 4 oz. and sea-coal 6. VI. Meal-powder 3 lb. charcoal 5 oz. and saw-dust $1\frac{1}{2}$.

16. *Sun Cases.*

I. Meal-powder $8\frac{1}{2}$ lb. saltpetre 1 lb. 2 oz. steel-dust 2 lb. 10 oz. brimstone 4. II. Meal-powder 3 lb. saltpetre 6 oz. and steel-dust $7\frac{1}{2}$.

17. *A brilliant Fire.*

Meal-powder 11 lb. saltpetre 1, brimstone 4 oz. steel-dust $1\frac{1}{2}$ lb.

18. *Gerbes.*

Meal-powder 6 lb. and beat-iron 2 lb. $1\frac{1}{2}$. oz.

19. *Chinese Fire.*

Saltpetre 12 oz. meal-powder 2 lb. brimstone 1 lb. 2 oz. and beat iron 12 oz.

20. *Tourbillons.*

Charge for four-ounce Tourbillons. Meal-powder 2 lb. 4 oz. and charcoal $4\frac{1}{2}$ oz.

Eight-ounce Tourbillons. Meal-powder 2 lb. and charcoal $4\frac{3}{4}$ oz.

Large Tourbillons. Meal-powder 2 lb. saltpetre 1, brimstone 8 oz. and beat iron 8.

N. B. Tourbillons may be made very large, and of different coloured fires: only you are to observe, that the larger they are, the weaker must be the charge; and, on the contrary, the smaller, the stronger their charge.

Ingredients and Compositions.

21. *Water Balloons.*

I. Saltpetre 4 lb. brimstone 2, meal-powder 2, antimony 4 oz. saw-dust 4, and glass-dust $1\frac{1}{4}$. II. Saltpetre 9 lb. brimstone 3 lb. meal-powder 6 lb. rosin 12 oz. and antimony 8 oz.

22. *Water Squibs.*

I. Meal-powder 1 lb. and charcoal 1 lb. II. Meal-powder 1 lb. and charcoal 9 oz.

23. *Mine Ports or Serpents.*

I. Meal-powder 1 lb. and charcoal 1 oz. II. Meal-powder 9 oz. charcoal 1 oz.

24. *Port-fires.*

For firing rockets, &c. I. Saltpetre 12 oz. brimstone 4 oz. and meal-powder 2 oz. II. Saltpetre 8 oz. brimstone 4 oz. and meal-powder 2 oz. III. Saltpetre 1 lb 2 oz. meal-powder $1\frac{1}{2}$ lb. and brimstone 10 oz. This composition must be moistened with one gill of linseed oil. IV. Meal-powder 6 oz. saltpetre 2 lb. 2 oz. and brimstone 10 oz. V. Saltpetre 1 lb. 4 oz. meal-powder 4 oz. brimstone 5 oz. saw-dust 8 oz. VI. Saltpetre 8 oz. brimstone 2 oz. and meal-powder 2 oz.

For illuminations. Saltpetre 1 lb. brimstone 8 oz. and meal-powder 6 oz.

25. *Cones or spiral Wheels.*

Saltpetre $1\frac{1}{2}$ lb. brimstone 6 oz. meal-powder 14 oz. and glass-dust 14 oz.

26. *Crowns or Globes.*

Saltpetre 6 oz. brimstone 2 lb. antimony 4 oz. and camphor 2 oz.

27. *Air Balloon Fuzes.*

I. Saltpetre 1 lb. 10 oz. brimstone 8 oz. and meal-powder 1 lb. 6 oz. II. Saltpetre $1\frac{1}{2}$ lb. brimstone 8 oz. and meal-powder 1 lb. 8 oz.

28. *Serpents for Pots des Brins.*

Meal-powder 1 lb. 8 oz. saltpetre 12 oz. and charcoal 2 oz.

29. *Fire Pumps.*

I. Saltpetre 5 lb. brimstone 1 lb. meal-powder $1\frac{1}{2}$ lb. and glass-dust 1 lb. II. Saltpetre 5 lb. 8 oz. brimstone 2 lb. meal-powder 1 lb. 8 oz. and glass-dust 1 lb. 8 oz.

30. *A slow white Flame.*

I. Saltpetre 2 lb. brimstone 3 lb. antimony 1 lb. II. Saltpetre $3\frac{1}{2}$ lb. sulphur $2\frac{1}{2}$ lb. meal-powder 1 lb. antimony $\frac{1}{2}$ lb. glass-dust 4 oz. brass-dust 1 oz.

N. B. These compositions, driven $1\frac{1}{4}$ inch in a 1 oz. case, will burn one minute, which is much longer time than an equal quantity of any composition yet known will last.

31. *Amber Lights.*

Meal-powder 9 oz. amber 3 oz. This charge may be drove in small cases, for illuminations.

32. *Lights of another Kind.*

Saltpetre 3 lb. brimstone 1 lb. meal-powder 1 lb. antimony $10\frac{1}{2}$ oz. All these must be mixed with the oil of spike.

33. *A red Fire.*

Meal-powder 3 lb. charcoal 12 oz. and saw-dust 8 oz.

34. *A common Fire.*

Saltpetre 3 lb. charcoal 10 oz. and brimstone 2 oz.

35. *To make an artificial Earthquake.*

Mix the following ingredients to a paste with water, and then bury it in the ground, and in a few hours the earth will break and open in several places. The composition: sulphur 4 lb. and steel-dust 4 lb.

36. *Compositions for Stars of different Colours.*

I. Meal-powder 4 oz. saltpetre 2 oz. brimstone 2 oz. steel-dust $1\frac{1}{2}$ oz. and camphor, white amber, antimony, and mercury-sublimate, of each $\frac{1}{2}$ oz. II. Rochepetre 10 oz. brimstone, charcoal, antimony, meal-powder, and camphor, of each $\frac{3}{4}$ oz. moistened with oil of turpentine. These compositions are made into stars, by being worked to a paste with aqua vitæ, in which has been dissolved some gum-tragacanth; and after you have rolled them in powder, make a hole through the middle of each, and string them on quick-match, leaving about 2 inches between each. III. Saltpetre 8 oz. brimstone 2 oz. yellow amber 1 oz. antimony 1 oz. and powder 3 oz. IV. Brimstone $2\frac{1}{2}$ oz. saltpetre 6 oz. olibanum or frankincense in drops 4 oz.; mastick, and mercury-sublimate, of each 4 oz. meal-powder 5 oz. white amber, yellow amber, and camphor, of each 1 oz. antimony and orpiment $\frac{1}{2}$ oz. each. V. Saltpetre 1 lb. brimstone $\frac{1}{2}$ lb. and meal-powder 8 oz. moistened with petrolio-oil. VI. Powder $\frac{1}{2}$ lb. brimstone and saltpetre, of each 4 oz. VII. Saltpetre 4 oz. brimstone 2 oz. and meal-powder 1 oz.

Stars that carry tails of sparks. I. Brimstone 6 oz. antimony crude 2 oz. saltpetre 4 oz. and rosin 4 oz. II. Saltpetre, rosin, and charcoal, of each 2 oz. brimstone 1 oz. and pitch 1 oz.

These compositions are sometimes melted in an earthen pan, and mixed with chopped cotton-match, before they are rolled into stars; but will do as well if wetted, and worked up in the usual manner.

Stars that yield some sparks. I. Camphor 2 oz. saltpetre 1 oz. meal-powder 1 oz. II. Saltpetre 1 oz. ditto melted $\frac{1}{2}$ oz. and camphor 2 oz. When you would make stars of either of these compositions, you must wet them with gum-water, or spirit of wine, in which has been dissolved some gum-arabic, or gum-tragacanth, that the whole may have the consistence of a pretty thick liquid; having thus done, take 1 oz. of lint, and stir it about in the composition till it becomes dry enough to roll into stars.

Stars of a yellowish colour. Take 4 oz. of gum-tragacanth or gum-arabic, pounded and sifted through a fine sieve, camphor dissolved in brandy 2 oz. saltpetre 1 lb. sulphur $\frac{1}{2}$ lb. coarse powder of glass 4 oz. white amber $1\frac{1}{2}$ oz. orpiment 2 oz. Being well incorporated, make them into stars after the common method.

Stars of another kind. Take 1 lb. of camphor, and melt it in a pint of spirit of wine over a slow fire; then add to it 1 lb. of gum-arabic that has been dissolved; with this liquor mix 1 lb. of saltpetre, 6 oz. of sulphur, and 5 oz. of meal-powder; and after you have stirred them well together, roll them into stars proportionable to the rockets for which you intend them.

37. *Colours produced by the different Compositions.*

As variety of fires adds greatly to a collection of works, it is necessary that every artist should know the different effect of each ingredient. For which reason, we shall here explain the colours they produce of themselves; and likewise how to make them retain the same when mixed with other bodies: as for example,

sulphur

Ingredients and Compoſitions.

ſulphur gives a blue, camphor a white or pale colour, ſaltpetre a clear white-yellow, amber a colour inclining to yellow, ſal-ammoniac a green, antimony a reddiſh, roſin a copper colour, and Greek-pitch a kind of bronze, or between red and yellow. All theſe ingredients are ſuch as ſhow themſelves in a flame, viz.

White flame. Saltpetre, ſulphur, meal-powder, and camphor; the ſaltpetre muſt be the chief part

Blue flame. Meal-powder, ſaltpetre, and ſulphur vivum; ſulphur muſt be the chief: Or meal-powder, ſaltpetre, brimſtone, ſpirit of wine, and oil of ſpike; but let the powder be the principal part.

Flame inclining to red. Saltpetre, ſulphur, antimony, and Greek-pitch; ſaltpetre the chief.

By the above method may be made various colours of fire, as the practitioner pleaſes; for, by making a few trials, he may cauſe any ingredient to be predominant in colour.

38. *Ingredients that ſhow in Sparks when rammed in choaked Caſes.*

The ſet colours of fire produced by ſparks are divided into 4 ſorts, viz. the black, white, grey, and red. The black charges are compoſed of 2 ingredients, which are meal-powder and charcoal; the white of 3, viz. ſaltpetre, ſulphur, and charcoal; the grey of 4, viz. meal-powder, ſaltpetre, brimſtone, and charcoal; and the red of 3, viz. meal-powder, charcoal, and ſaw-duſt.

There are, beſides theſe four regular or ſet charges, two others, which are diſtinguiſhed by the names of *compound* and *brilliant charges*; the compound being made of many ingredients, ſuch as meal-powder, ſaltpetre, brimſtone, charcoal, ſaw-duſt, ſea-coal, antimony, glaſs duſt, braſs duſt, ſteel filings, caſt iron, tanner's duſt, &c. or any thing that will yield ſparks; all which muſt be managed with diſcretion. The brilliant fires are compoſed of meal-powder, ſaltpetre, brimſtone, and ſteel duſt; or with meal-powder and ſteel filings only.

39. *Cotton Quick-match,*

Is generally made of ſuch cotton as is put in candles, of ſeveral ſizes, from 1 to 6 threads thick, according to the pipe it is deſigned for; which pipe muſt be large enough for the match, when made, to be puſhed in eaſily without breaking it. Having doubled the cotton into as many threads as you think proper, coil it very lightly into a flat-bottomed copper or earthen pan; then put in the ſaltpetre and the liquor, and boil them about 20 minutes; after which coil it again into another pan, as in fig. 4. and pour on it what liquor remains; then put in ſome meal-powder, and preſs it down with your hands till it is quite wet; afterwards place the pan before the wooden frame (fig. 5.) which muſt be ſuſpended by a point in the centre of each end; and place yourſelf before the pan, tying the upper end of the cotton to the end of one of the ſides of the frame.

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When every thing is ready, you muſt have one to turn the frame round, while you let the cotton paſs through your hands, holding it very lightly, and at the ſame time keeping your hands full of the wet powder; but if the powder ſhould be too wet to ſtick to the cotton, put more in the pan, ſo as to keep a continual ſupply till the match is all wound up; you may wind it as cloſe on the frame as you pleaſe, ſo that it do not ſtick together; when the frame is full, take it off the points, and ſift dry meal-powder on both ſides the match, till it appear quite dry: in winter the match will be a fortnight before it is fit for uſe; when it is thoroughly dry, cut it along the outſide of one of the ſides of the frame, and tie it up in ſkins for uſe.

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N. B. The match muſt be wound tight on the frames.

The ingredients for the match, are, cotton 1 lb. 12 oz. ſaltpetre 1 lb. ſpirit of wine 2 quarts, water 3 quarts, iſinglaſs 3 gills, and meal-powder 10 lb. To diſſolve 4 oz. of iſinglaſs, take 3 pints of water.

2d 39. *Touch-paper for capping of Serpents, Crackers*, &c.

Diſſolve, in ſpirits of wine or vinegar, a little ſaltpetre; then take ſome purple or blue paper, and wet it with this liquor, and when dry it will be fit for uſe; when you paſte this paper on any of your works, take care that the paſte does not touch that part which is to burn. The method of uſing this paper is by cutting it into ſlips, long enough to go once round the mouth of a ſerpent, cracker, &c. When you paſte on theſe ſlips, leave a little above the mouth of the caſe not paſted; then prime the caſe with meal-powder, and twiſt the paper to a point.

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40. *Rocket moulds.*

As the performance of rockets depends much on their moulds, it is requiſite to give a definition of them and their proportions: They are made and proportioned by the diameter of their orifice, which are divided into = parts. Fig. 6. repreſents a mould made by its diameter AB: its height from C to D is 6 diameters and 2 thirds; from D to E is the height of the foot, which is 1 diameter and 2 thirds; F the choak or cylinder, whoſe height is 1 diameter and 1-3d; it muſt be made out of the ſame piece as the foot, and fit tight in the mould; G an iron pin that goes through the cylinder to keep the foot faſt; H the nipple, which is $\frac{1}{2}$ a diameter high, and 2-3ds thick, and of the ſame piece of metal as the former I, whoſe height is $3\frac{1}{2}$ diameters, and at the bottom is 1-3d of the diameter thick, and from thence tapering to 1-6th of the diameter. The beſt way to fix the piercer in the cylinder, is to make that part below the nipple long enough to go quite through the foot, and rivet at bottom. Fig. 7. is a former or roller for the caſes, whoſe length from the handle is $7\frac{1}{2}$ diameters, and its diameter 2-3ds of the bore. Fig. 8. the end of the former, which is of the ſame thickneſs, and 1 diameter and 2-3ds long; the ſmall part, which fits into the hole in the end of the roller when the caſe is pinching, is 1-6th and $\frac{1}{2}$ of the mould's diameter thick. Fig. 9. the firſt drift, which muſt be 6 diameters from the handle; and this, as well as all other rammers, muſt be a little thinner than the former, to prevent the ſacking of the paper when you are driving in the charge. In the end of this rammer is a hole to fit over the piercer: the line K marked on this is 2 diameters and 1-3d from the handle; ſo that, when you are filling the rocket, this line appears at top of the caſe: you muſt then take the 2d rammer (fig. 10.) which from the handle is 4

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diameters, and the hole for the piercer is $1\frac{1}{2}$ diameter long. Fig. 11. is the ſhort and ſolid drift which you uſe when you have filled the caſe as high as the top of the piercer.

Rammers muſt have a collar of braſs at the bottom, to keep the wood from ſpreading or ſplitting, and the ſame proportion muſt be given to all moulds, from 1 oz. to 6 lb. We mentioned nothing concerning the handles of the rammers; however, if their diameter be equal to the bore of the mould, and 2 diameters long, it will be a very good proportion: but the ſhorter you can uſe them, the better; for the longer the drift, the leſs will be the preſſure on the compoſition by the blow given with the mallet.

Dimenſions for Rocket Moulds, if the Rockets are rammed ſolid.

Weight of rockets.	Length of the moulds without their feet.	Interior diameter of the moulds.	Height of the nipples.
lb. oz.	Inches.	Inches.	Inches.
6 0	34,7	3,5	1,5
4 0	38,6	2,9	1,4
2 0	13,35	2,1	1,0
1 0	12;25	1,7	0,85
0 8	10,125	1,333, &c.	0,6
0 4	7,75	1,125	0,5
0 2	6,2	0,9	0,45
0 1	4,9	0,7	0,35
0 $\frac{1}{2}$	3,9	0,55	0,25
6 drams	3,5	0,5	0,225
4 drams	2,1	0,3	0,2

The diameter of the nipple muſt always be equal to that of the former.

The thickneſs of the moulds is omitted, being very immaterial, provided they are ſubſtantial and ſtrong.

Our author adviſes thoſe who make rockets for private amuſement, not to ram them ſolid; for it requires a very ſkilful hand, and an expenſive apparatus for boring them, which will be ſhown hereafter. Driving of rockets ſolid is the moſt expeditious method, but not ſo certain as ramming them over a piercer.

41. *Moulds for Wheel-caſes or Serpents.*

Fig. 12. repreſents a mould, in which the caſes are drove ſolid; L the nipple (A), with a point (B) at top, which, when the caſe is filling, ſerves to ſtop the neck, and prevent the compoſition from falling out, which without this point it would do; and, in conſequence, the air would get into the vacancy in the charge, and at the time of firing cauſe the caſe to burſt. Theſe ſort of moulds are made of any length or diameter, according as the caſes are required; but the diameter of the rollers muſt be equal to half the bore, and the rammers made quite ſolid.

42. *To roll Rocket and other Caſes.*

Sky-rocket caſes are to be made $6\frac{1}{2}$ of their exterior diameter long; and all other caſes that are to be filled in moulds muſt be as long as the moulds, within half its interior diameter.

Rocket caſes, from the ſmalleſt to 4 or 6 lb. are generally made of the ſtrongeſt ſort of cartridge paper, and rolled dry; but the large ſort are made of paſted paſteboard. As it is very difficult to roll the ends of the caſes quite even, the beſt way will be to keep a pattern of the paper for the different ſorts of caſes; which pattern ſhould be ſomewhat longer than the caſe it is deſigned for, and on it marked the number of ſheets required, which will prevent any paper being cut to waſte. Having cut your papers of a proper ſize, and the laſt ſheet for each caſe with a ſlope at one end, ſo that when the caſes are rolled it may form a ſpiral line round the outſide, and that this ſlope may always be the ſame, let the pattern be ſo cut for a guide. Before you begin to roll, fold down one end of the firſt ſheet, ſo far that the fold will go 2 or 3 times round the former: then, on the double edge, lay the former with its handle off the table; and when you have rolled on the paper within 2 or 3 turns, lay the next ſheet on that part which is looſe, and roll it all on.

Having thus done, you muſt have a ſmooth board, about 20 inches long, and equal in breadth to the length of the caſe. In the middle of this board muſt be a handle placed lengthwiſe. Under this board lay your caſe, and let one end of the board lie on the table; then preſs hard on it, and puſh it forwards, which will roll the paper very tight: do this three or four times before you roll on any more paper. This muſt be repeated every other ſheet of paper, till the caſe is thick enough; but if the rolling board be drawn backwards, it will looſen the paper: you are to obſerve, when you roll on the laſt ſheet, that the point of the ſlope be placed at the ſmall end of the roller. Having rolled your caſe to fit the mould, puſh in the ſmall end of the former F, about 1 diameter from the end of the caſe, and put in the end-piece within a little diſtance of the former; then give the pinching cord one turn round the caſe, between the former and the end-piece; at firſt pull eaſy, and keep moving the caſe, which will make the neck ſmooth, and without large wrinkles. When the caſes are hard to choak, let each ſheet of paper (except the firſt and laſt, in that part where the neck is formed) be a little moiſtened with water: immediately after you have ſtruck the concave ſtroke, bind the neck of the caſe round with ſmall twine, which muſt not be tied in a knot, but faſtened with two or three hitches.

Having thus pinched and tied the caſe ſo as not to give way, put it into the mould without its foot, and with a mallet drive the former hard on the end-piece, which will force the neck cloſe and ſmooth. This done, cut the caſe to its proper length, allowing from the neck to the edge of the mouth half a diameter, which is equal to the height of the nipple; then take out the former, and drive the caſe over the piercer with the long rammer, and the vent will be of a proper ſize. Wheel-caſes muſt be drove on a nipple with a point to cloſe

(A) The nipple and cylinders to bear the ſame proportion as thoſe for rockets.
(B) A round bit of braſs, equal in length to the neck of the caſe, and flat at the top.

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close the neck, and make the vent of the size required; which, in most cases, is generally $\frac{1}{4}$ of their interior diameter. As it is very often difficult, when the cases are rolled, to draw the roller out, you may make a hole through the handle, and put in it a small iron pin, by which you may easily turn the former round and pull it out. Fig. 17. shows the method of pinching cases; P a treddle, which, when pressed hard with the foot, will draw the cord tight, and force the neck as close as you please; Q a small wheel or pulley, with a groove round it for the cord to run in.

Cases are commonly rolled wet, for wheels and fixed pieces; and when they are required to contain a great length of charge, the method of making those cases is thus: Your paper must be cut as usual, only the last sheet must not be cut with a slope: having your paper ready, paste each sheet on one side; then fold down the first sheet as before directed: but be careful that the paste do not touch the upper part of the fold; for if the roller be wetted, it will tear the paper in drawing it out. In pasting the last sheet, observe not to wet the last turn or two in that part where it is to be pinched; for if that part be damp, the pinching cord will stick to it, and tear the paper; therefore, when you choak those cases, roll a bit of dry paper once round the case, before you put on the pinching cord; but this bit of paper must be taken off after the case is choaked. The rolling board, and all other methods, according to the former directions for the rolling and pinching of cases, must be used to these as well as all other cases.

43. *To make Tourbillon Cases.*

Those sort of cases are generally made about 8 diameters long; but if very large, 7 will be sufficient: tourbillons will answer very well from 4 oz. to 2 lb. but when larger there is no certainty. The cases are best rolled wet with paste, and the last sheet must have a straight edge, so that the case may be all of a thickness: when you have rolled your cases after the manner of wheel-cases, pinch them at one end quite close; then with the rammer drive the ends down flat, and afterwards ram in about 1-3d of a diameter of dried clay. The diameter of the former for these cases must be the same as for sky-rockets.

N. B. Tourbillons are to be rammed in moulds without a nipple, or in a mould without its foot.

44. *Balloon Cases, or Paper Shells.*

First, you must have an oval former turned of smooth wood; then paste a quantity of brown or cartridge paper, and let it lie till the paste has quite soaked through; this done, rub the former with soap or grease, to prevent the paper from sticking to it; then lay the paper on in small slips, till you have made it 1-3d of the thickness of the shell intended. Having thus done, set it to dry; and when dry, cut it round the middle, and the two halves will easily come off: but observe, when you cut, to leave about 1 inch not cut, which will make the halves join much better than if quite separated. When you have some ready to join, place the halves even together, paste a slip of paper round the opening to hold them together, and let that dry; then lay on paper all over as before, everywhere equal, excepting that end which goes downwards in the mortar, which may be a little thicker than the rest; for that part which receives the blow from the powder in the chamber of the mortar consequently requires the greatest strength. When the shell is thoroughly dry, burn a round vent at top, with square iron, large enough for the fuze: this method will do for balloons from 4 inches 2-5ths, to 8 inches diameter; but if they are larger, or required to be thrown a great height, let the first shell be turned of elm, instead of being made of paper.

For a balloon of 4 inches 2-5ths, let the former be 3 inches 1-8th diameter, and $5\frac{1}{2}$ inches long. For a balloon of $5\frac{1}{2}$ inches, the diameter of the former must be 4 inches, and 8 inches long. For a balloon of 8 inches, let the diameter of the former be 5 inches and 15-16ths, and 11 inches 7-8ths long. For a 10-inch balloon, let the former be 7 inches 3-16ths diameter, and $14\frac{1}{2}$ inches long. The thickness of a shell for a balloon of 4 inches 2-5ths, must be $\frac{1}{4}$ inch. For a balloon of $5\frac{1}{2}$ inches, let the thickness of the paper be 5-8ths of an inch. For an 8-inch balloon, 7-8ths of an inch. And for a 10-inch balloon, let the shell be 1 inch 1-8th thick.

Shells that are designed for stars only, may be made quite round, and the thinner they are at the opening, the better; for if they are too strong, the stars are apt to break at the bursting of the shell: when you are making the shell, make use of a pair of calibres, or a round gage, so that you may not lay the paper thicker in one place than another; and also to know when the shell is of a proper thickness. Balloons must always be made to go easy into the mortars.

Cases for illumination Port-fires. These must be made very thin of paper, and rolled on formers, from 2 to 5-8ths of an inch diameter, and from 2 to 6 inches long: they are pinched close at one end, and left open at the other. When you fill them, put in but a little composition at a time, and ram it in lightly, so as not to break the case: 3 or 4 rounds of paper, with the last round pasted, will be strong enough for these cases.

Cases and moulds for common Port-fires. Common port-fires are intended purposely to fire the works, their fire being very slow, and the heat of the flame so intense, that, if applied to rockets, leaders, &c. it will fire them immediately. Port-fires may be made of any length, but are seldom made more than 21 inches long: the interior diameter of port-fire moulds should be 10-16ths of an inch, and the diameter of the former $\frac{1}{4}$ an inch. The cases must be rolled wet with paste, and one end pinched, or folded down. The moulds should be made of brass, and to take in two pieces lengthwise; when the case is in the two sides, they are held together by brass rings, or hoops, which are made to fit over the outside. The bore of the mould must not be made quite through, so that there will be no occasion for a foot. Those port-fires, when used, are held in copper sockets, fixed on the end of a long stick: these sockets are made like port-crayons, only with a screw instead of a ring.

45. *Of mixing the Compositions.*

The performance of the principal part of fire-works depends much on the compositions being well mixed; therefore great care must be taken in this part of the work, particularly for the composition for sky-rockets. When you have 4 or 5 pounds of ingredients to mix, which is a sufficient quantity at a time (for a larger

proportion

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proportion will not do so well), first put the different ingredients together; then work them about with your hands, till you think they are pretty well incorporated: after which put them into a lawn sieve with a receiver and top to it; and if, after it is sifted, any remains that will not pass through the sieve, grind it again till fine enough; and if it be twice sifted, it will not be amiss; but the compositions for wheels and common works are not so material, nor need be so fine. But in all fixed works, from which the fire is to play regular, the ingredient must be very fine, and great care taken in mixing them well together; and observe, that in all compositions wherein are steel or iron filings, the hands must not touch; nor will any works which have iron or steel in their charge keep long in damp weather, unless properly prepared, according to the following directions.

46. *To preserve Steel or Iron filings.*

It sometimes may happen, that fire-works may be required to be kept a long time, or sent abroad; neither of which could be done with brilliant fires, if made with filings unprepared; for this reason, that the saltpetre being of a damp nature, it causes the iron to rust; the consequence of which is, that when the works are fired, there will appear but very few brilliant sparks, but instead of them a number of red and drossy sparks; and besides, the charge will be so much weakened, that if this was to happen to wheels, the fire will hardly be strong enough to force them round. But to prevent such accidents, prepare your filings thus: Melt in a glazed earthen pan some brimstone over a slow fire, and when melted throw in some filings; which keep stirring about till they are covered with brimstone: this you must do while it is on the fire; then take it off, and stir it very quick till cold, when you must roll it on a board with a wooden roller, till you have broke it as fine as corn powder; after which sift from it as much of the brimstone as you can. There is another method of preparing filings, so as to keep 2 or 3 months in winter; this may be done by rubbing them between the strongest sort of brown paper, which before has been moistened with lintseed oil.

N. B. If the brimstone should take fire, you may put it out, by covering the pan close at top: it is not of much signification what quantity of brimstone you use, so that there is enough to give each grain of iron a coat; but as much as will cover the bottom of a pan of about 1 foot diameter, will do for 5 or 6 pound of filings, or cast-iron for gerbes.

47. *To drive or ram Sky-rockets*, &c.

Rockets drove over a piercer must not have so much composition put in them at a time as when drove solid; for the piercer, taking up great part of the bore of the case, would cause the rammer to rise too high; so that the pressure of it would not be so great on the composition, nor would it be drove everywhere equal. To prevent this, observe the following rule: That for those rockets which are rammed over a piercer, let the ladle (c) hold as much composition as, when drove, will raise the drift $\frac{1}{2}$ the interior diameter of the case, and for those drove solid to contain as much as will raise it $\frac{1}{2}$ the exterior diameter of the case: ladles are generally made to go easy in the case, and the length of the scoop about $1\frac{1}{2}$ of its own diameter.

The charge of rockets must always be drove 1 diameter above the piercer, and on it must be rammed 1-3d of a diameter of clay; through the middle of which bore a small hole to the composition, that, when the charge is burnt to the top, it may communicate its fire, through the hole, to the stars in the head. Great care must be taken to strike with the mallet, and with an equal force, the same number of strokes to each ladle-full of charge; otherwise the rockets will not rise with an uniform motion, nor will the composition burn equal and regular: for which reason they cannot carry a proper tail; for it will break before the rocket has got half way up, instead of reaching from the ground to the top, where the rocket breaks and disperses the stars, rains, or whatever is contained in the head. When you are ramming, keep the drift constantly turning or moving; and when you use the hollow rammers, knock out of them the composition now and then, or the piercer will split them. To a rocket of 4 oz. give to each ladle-full of charge 16 strokes; to a rocket of 1 lb. 28; to a 2-pounder, 36; to a 4-pounder, 42; and to a 6-pounder, 56: but rockets of a larger sort cannot be drove well by hand, but must be rammed with a machine made in the same manner as those for driving piles.

The method of ramming of wheel-cases, or any other sort, in which the charge is drove solid, is much the same as sky-rockets; for the same proportion may be observed in the ladle, and the same number of strokes given, according to their diameters, all cases being distinguished by their diameters. In this manner, a case, whose bore is equal to a rocket of 4 oz. is called a 4-oz. case, and that which is equal to an 8-oz rocket an 8-oz. case, and so on, according to the different rockets.

Having taught the method of ramming cases in moulds, we shall here say something concerning those filled without moulds; which method, for strong pasted cases, will do extremely well, and save the expence of making so many moulds. The reader must here observe, when he fills any sort of cases, to place the mould on a perpendicular block of wood, and not on any place that is hollow; for we have found by experience, that when cases were rammed on driving benches, which were formerly used, the works frequently miscarried, on account of the hollow resistance of the benches, which oft jarred and loosened the charge in the cases; but this accident never happens when the driving blocks are used (d).

When cases are to be filled without moulds, proceed thus. Have some nipples made of brass or iron, of several sorts and sizes, in proportion to the cases, and to screw or fix in the top of the driving block; when you have fixed in a nipple, make, at about $1\frac{1}{2}$ inch

(c) A copper scoop with a wooden handle.
(d) A piece of hard wood in the form of an anvil block.

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inch from it, a square hole in the block, 6 inches deep and 1 inch diameter; then have a piece of wood, 6 inches longer than the case intended to be filled, and 2 inches square; on one side of it cut a groove almost the length of the case, whose breadth and depth must be sufficient to cover near ½ the case; then cut the other end to fit the hole in the block, but take care to cut it so that the groove may be of a proper distance from the nipple; this half mould being made and fixed tight in the block, cut, in another piece of wood nearly of the same length as the case, a groove of the same dimensions as that in the fixed piece; then put the case on the nipple, and with a cord tie it and the 2 half-moulds together, and your case will be ready for filling.

The dimensions of the above-described half-moulds are proportionable for cases of 8 ounces; but notice must be taken, that they differ in size in proportion to the cases.

Note, The clay, mentioned in this article, must be prepared after this manner: Get some clay, in which there is no stones nor sand, and bake it in an oven till quite dry; then take it out and beat it to a powder, and afterwards sift it through a common hair-sieve, and it will be fit for use.

48. *Proportion of Mallets.*

The best wood for mallets is dry beech. If a person uses a mallet of a moderate size, in proportion to the rocket, according to his judgment, and if the rocket succeeds, he may depend on the rest, by using the same mallet; yet it will be necessary that cases of different sorts be drove with mallets of different sizes.

The following proportion of the mallets for rockets of any size, from 1 oz. to 6 lb. may be observed; but as rockets are seldom made less than 1 oz. or larger than 6 lb. we shall leave the management of them to the curious; but all cases under 1 oz. may be rammed with an oz. rocket mallet. Your mallets will strike more solid, by having their handles turned out of the same piece as the head, and made in a cylindrical form. Let their dimensions be worked by the diameters of the rockets: for example; let the thickness of the head be 3 diameters, and its length 4, and the length of the handle 5 diameters, whose thickness must be in proportion to the hand.

49. *Proportion of Sky-rockets, and manner of heading them.*

Fig. 13. represents a rocket complete without its stick, whose length from the neck is 5 diameters 1-6th: the cases should always be cut to this length after they are filled. M is the head, which is 2 diameters high, and 1 diameter 1-6th ½ in breadth; N the cone or cap, whose perpendicular height must be 1 diameter 1-3d. Fig. 14. the collar to which the head is fixed: this is turned out of deal or any light wood, and its exterior diameter must be equal to the interior diameter of the head; 1-6th will be sufficient for its thickness, and round the outside edge must be a groove; the interior diameter of the collar must not be quite so wide as the exterior diameter of the rocket: when this is to be glued on the rocket, you must cut two or three rounds of paper off the case, which will make a shoulder for it to rest upon. Fig. 15. a former for the head: two or three rounds of paper well pasted will be enough for the head, which, when rolled, put the collar on that part of the former marked O, which must fit the inside of it; then, with the pinching cord pinch the bottom of the head into the groove, and tie it with small twine. Fig. 16. a former for the cone. To make the caps, cut your paper in round pieces, equal in diameter to twice the length of the cone you intend to make; which pieces being cut into halves, will make two caps each, without wasting any paper; having formed the caps, paste over each of them a thin white paper, which must be a little longer than the cone, so as to project about ½ an inch below the bottom: this projection of paper, being notched and pasted, serves to fasten the cap to the head.

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When you load the heads of your rockets, with stars, rains, serpents, crackers, scrolls, or any thing else, according to your fancy, remember always to put 1 ladleful of meal-powder into each head, which will be enough to burst the head, and disperse the stars, or whatever it contains: when the heads are loaded with any sort of cases, let their mouths be placed downwards; and after the heads are filled, paste on the top of them a piece of paper, before you put on the caps. As the size of the stars often differ, it would be needless to give an exact number for each rocket; but this rule may be observed, that the heads may be nearly filled with whatever they are loaded.

50. *Decorations for Sky-rockets.*

Sky-rockets bearing the pre-eminence of all fire-works, it will not be improper to treat of their various kinds of decorations, which are directed according to fancy. Some are headed with stars of different sorts, such as tailed, brilliant, white, blue, and yellow stars, &c.; some with gold and silver rain; others with serpents, crackers, firescrolls, marrons; and some with small rockets, and many other devices, as the maker pleases.

Dimensions and poise of Rocket-sticks.

Weight of the rocket.	Length of the stick.	Thickness at top.	Breadth at top.	Square at bottom.	Poise from the point of the cone.
L. oz.	F. in.	Inches.	Inches.	Inches.	F. in.
6 0	14 0	1,5	1,85	0,75	4 1,5
4 0	12 10	1,25	1,40	0,625	3 9,
2 0	9 4	1,125	1,	0,525	2 9,
1 0	8 2	0,725	0,80	0,375	2 1,
8	6 6	0,5	0,70	0,25	1 10,5
4	5 3	0,3750	0,55	0,35	1 8,5
2	4 1	0,3	0,45	0,15	1 3,
1	3 6	0,25	0,35	0,10	11 0,
½	2 4	0,125	0,20	0,16	8 0,
¼	1 10½	0,1	0,15	0,5	5 0,5

The last column on the right, in the above table, expresses the distance from the top of the cone, where the stick, when tied on, should balance the rocket, so as to stand in an equilibrium on one's finger or the edge of a knife. The best wood for the sticks is dry deal, made thus. When you have cut and planed the sticks according to the dimensions given in the table, cut, on one of the flat sides at the top, a groove the length of the rocket, and as broad as the stick will allow; then, on the opposite flat side, cut two notches for the cord, which ties on the rocket, to lie in; one of these notches must be near the top of the stick,

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and the other facing the neck of the rockets; the distance between these notches may easily be known, for the top of the stick should always touch the head of the rocket. When your rockets and sticks are ready, lay the rockets in the grooves in the sticks, and tie them on. Those who, merely for curiosity, may choose to make rockets of different sizes, from those expressed in the table of dimensions, may find the length of their sticks, by making them for rockets, from $\frac{1}{4}$ oz. to 1 lb. 60 diameters of the rocket long; and for rockets above 1 lb. 50 or 52 diameters will be a good length; their thickness at top may be about $\frac{1}{4}$ a diameter, and their breadth a very little more; their square at bottom is generally equal to $\frac{1}{2}$ the thickness at top. But although the dimensions of the sticks be very nicely observed, you must depend only on their balance; for, without a proper counterpoise, your rockets, instead of mounting perpendicularly, will take an oblique direction, and fall to the ground before they are burnt out.

51. *Boring Rockets which have been driven solid.*

Fig. 18. represents the plan of an apparatus, or lathe, for boring of rockets. A the large wheel, which turns the small one B, that works the rammer C: these rammers are of different sizes according to the rockets; they must be of the same diameter as the top of the bore intended, and continue that thickness a little longer than the depth of the bore required, and their points must be like that of an augre: the thick end of each rammer must be made square, and all of the same size, so as to fit into one socket, wherein they are fastened by a screw D. E the guide for the rammer, which is made to move backwards and forwards: so that, after you have marked the rammer $3\frac{1}{2}$ diameters of the rocket from the point, set the guide, allowing for the thickness of the fronts of the rocket boxes, and the neck and mouth of the rocket; so that when the front of the large box is close to the guide, the rammer may not go too far up the charge. F, boxes for holding the rockets, which are made so as to fit one in another; their sides must be equal in thickness to the difference of the diameters of the rockets, and their interior diameters equal to the exterior diameters of the rockets. To prevent the rocket's turning round while boring, a piece of wood must be placed against the end of the box in the inside, and pressed against the tail of the rocket; this will also hinder the rammer from forcing the rocket backwards. G, a rocket in the box. H, a box that slides under the rocket-boxes to receive the borings for the rockets, which fall through holes made on purpose in the boxes; these holes must be just under the mouth of the rocket, one in each box, and all to correspond with each other.

Fig. 19. is a front view of the large rocket-box. I, an iron plate, in which are holes of different sizes, through which the rammer passes: this plate is fastened with a screw in the centre, so that when you change the rammer, you turn the plate round, but always let the hole you are going to use be at the bottom: the fronts of the other boxes must have holes in them to correspond with those in the plate. K, the lower part of the large box; which is made to fit the inside of the lathe, that all the boxes may move quite steady.

Fig. 20. is a perspective view of the lathe. L, the guide for the rammer, which is set by the screw at bottom.

Fig. 21. A view of the front of the guide facing the rammer. M, an iron plate, of the same dimensions as that on the front of the box, and placed in the same direction, and also to turn on a screw in the centre. N, the rocket-box which slides backwards and forwards: when you have fixed a rocket in the box, push it forwards against the rammer; and when you think the scoop of the rammer is full, draw the box back, and knock out the composition: this you must do till the rocket is bored, or it will be in danger of taking fire; and if you bore in a hurry, wet the end of the rammer now and then with oil to keep it cool.

Having bored a number of rockets, you must have taps of different sorts according to the rockets. These taps are a little longer than the bore: but when you use them, mark them $3\frac{1}{2}$ diameters from the point, allowing for the thickness of the rocket's neck; then, holding the rocket in one hand, you tap it with the other. One of these taps is represented by fig. 22. They are made in the same proportion as the fixed piercers, and are hollowed their whole length.

52. *Hand Machine used for boring of Rockets instead of a Lathe.*

These sort of machines answer very well, though not so expeditious as the lathes. But they are not so expensive to make, and they may be worked by one man; whereas the lathe will require three. Fig. 23. represents the machine. O, the rocket boxes, which are to be fixed, and not to slide as those in the lathe. PQ are guides for the rammers, that are made to slide together, as the rammer moves forward: the rammers for these sorts of machines must be made of a proper length, allowing for the thickness of the front of the boxes, and the length of the mouth and neck of the case; on the square end of these rammers must be a round shoulder of iron, to turn against the outside of the guide Q, by which means the guides are forced forwards. R, the stock which turns the rammer, and while turning must be pressed towards the rocket by the body of the man who works it; all the rammers are to be made to fit one stock.

To make large Gerbes.

Plate CCCCXXII.

Fig. 1. represents a wooden former; fig. 2. a gerbe complete, with its foot or stand. The cases for gerbes are made very strong, on account of the strength of the composition; which, when fired, comes out with great velocity: therefore, to prevent their bursting, the paper should be pasted, and the cases made as thick at the top as at the bottom. They should also have very long necks, for this reason; first, that the particles of iron will have more time to be heated, by meeting with greater resistance in getting out, than with a short neck, which would be burnt too wide before the charge be consumed, and spoil the effect: secondly, that with long necks the stars will be thrown to a great height, and will not fall before they are spent, or spread too much; but, when made to perfection, will rise and spread in such a manner as to form exactly a wheat-sheaf.

In the ramming of gerbes, there will be no need of a mould, the cases being sufficiently strong to support themselves.

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themselves. But you are to be careful, before you begin to ram, to have a piece of wood made to fit in the neck; for if this be not done, the composition will fall into the neck, and leave a vacancy in the case, which will cause the case to burst so soon as the fire arrives at the vacancy. You must likewise observe, that the first ladle of charge, or second, if you think proper, be of some weak composition. When the case is filled, take out the piece of wood, and fill the neck with some slow charge. Gerbes are generally made about 6 diameters long, from the bottom to the top of the neck; their bore must be 1-5th narrower at top than at bottom. The neck S is 1-6th diameter and $\frac{1}{4}$ long. T, a wooden foot or stand, on which the gerbe is fixed. This may be made with a choak or cylinder 4 or 5 inches long to fit the inside of the case, or with a hole in it to put in the gerbe; both these methods will answer the same. Gerbes produce a most brilliant fire, and are very beautiful when a number of them are fixed in the front of a building or a collection of fireworks.

N. B. Gerbes are made by their diameters, and their cases at bottom $\frac{1}{4}$ thick. The method of finding the interior diameter of a gerbe is thus: Supposing you would have the exterior diameter of the case, when made, to be 5 inches, then, by taking 2-4ths for the sides of the case, there will remain $2\frac{1}{2}$ inches for the bore, which will be a very good size. These sort of gerbes should be rammed very hard.

54. *Small Gerbes, or white Fountains,*

May be made of 4 oz. 8 oz. or 1 lb. cases, pasted and made very strong, of what length you please: but, before you fill them, drive in clay one diameter of their orifice high; and when you have filled a case, bore a vent through the centre of the clay to the composition: the common proportion will do for the vent, which must be primed with a slow charge. These sort of cases, without the clay, may be filled with Chinese fire.

Plate CCCCXXIX.

55. *To make Pasteboard and Paper Mortars.*

Fig. 3. represents a former, and fig. 4. an elm foot, for the mortar. Fig. 5. represents a mortar complete: these mortars are best when made with pasteboard, well pasted before you begin; or, instead of paste, you may use glue. For a coehorn mortar, which is 4 inches 2-5ths diameter, roll the pasteboard on the former 1-6th of its diameter thick; and, when dry, cut one end smooth and even; then nail and glue it on the upper part of the foot: when done, cut off the pasteboard at top, allowing for the length of the mortar $2\frac{1}{2}$ diameters from the mouth of the powder-chamber; then bind the mortar round with a strong cord wetted with glue. U, the bottom part of the foot 1 diameter 2-3ds broad, and 1 diameter high; and that part which goes into the mortar is 2-3ds of its diameter high. W, is a copper chamber for powder, made in a conical form; and is 1-3d of the diameter wide, $1\frac{1}{2}$ of its own diameter long. In the centre of the bottom of this chamber, make a small hole a little way down the foot; this hole must be met by another of the same size, made in the side of the foot, as is shown in the figure. If these holes are made true, and a copper pipe fitted into both, the mortar when loaded will prime itself; for the powder will naturally fall to the bottom of the first hole; then by putting a bit of quick-match in the side hole, your mortar will be ready to be fired.

Air-balloons, &c.

Mortars of $5\frac{1}{2}$, eight and ten inches diameter, may be made of paper or pasteboard, by the above method, and in the same proportion; but if larger, it will be best to have them made of brass. *N. B.* The copper chamber must have a small rim round its edge with holes in it, for screws to make it fast in the foot.

SECT. III. *To load Air-balloons, with the number of Stars, Serpents, Snakes, Rain-falls, &c. in Shells of each nature.*

56. *Mortars to throw Aigrettes, &c.*

WHEN you fill your shells, you must first put in the serpents, rains, stars, &c. or whatever they are composed of; then the blowing powder; but the shells must not be quite filled. All those things must be put in at the fuze hole; but marrons being too large to go in at the fuze hole, must be put in before the inside shell be joined. When the shells are loaded, glue and drive in the fuzes very tight. For a coehorn balloon, let the diameter of the fuze hole be $\frac{7}{8}$ths of an inch; for a royal balloon, which is near $5\frac{1}{2}$ inches diameter, make the fuze hole 1 inch $\frac{1}{8}$th diameter; for an 8-inch balloon, 1 inch $\frac{3}{8}$ths; and for a 10-inch balloon, 1 inch $\frac{5}{8}$ths.

Air-balloons are divided into 4 sorts; viz. first, illuminated balloons; second, balloons of serpents; third, balloons of reports, marrons, and crackers; and fourth, compound balloons. The number and quantities of each article for the different shells are as follow.

Coehorn balloon illuminated. oz.

Meal powder		- - -	$1\frac{1}{2}$
Corn powder		- - -	$0\frac{1}{2}$
Powder for the mortar		- -	2

Length of the fuze composition, $\frac{3}{4}$ths of an inch; 1 oz. drove or rolled stars, as many as will nearly fill the shell.

Coehorn balloon of serpents. oz.

Meal powder		- - -	$1\frac{1}{4}$
Corn powder		- - -	1
Powder for the mortar		- - -	$2\frac{1}{4}$

Length of the fuze composition $\frac{13}{16}$ths of an inch: half-ounce cases drove 3 diameters, and bounced 3 diameters, and half-ounce cases drove 2 diameters and bounced 4, of each an equal quantity, and as many of them as will fit in easily placed head to tail.

Coehorn balloons of crackers and reports. oz.

Meal powder		- - -	$1\frac{1}{4}$
Corn powder		- - -	$0\frac{3}{4}$
Powder for the mortar		- - -	2

Length of the fuze composition $\frac{3}{4}$ths of an inch. Reports 4, and crackers of 6 bounces as many as will fill the shell.

Compound coehorn balloons. oz. dr.

Meal powder		- - -	1 4
Corn powder		- - -	0 12
Powder for the mortar		- -	2 4

Length of the fuze composition $\frac{13}{16}$ths of an inch: $\frac{1}{2}$ ounce cases drove $3\frac{1}{2}$ diameters and bounced 2, 16; $\frac{1}{2}$ ounce cases drove 4 diameters and not bounced 10; blue strung stars, 10; rolled stars, as many as will complete the balloon.

Air-balloons, &c.

Royal balloons illuminated.

		oz.	dr.
Meal powder		1	8
Corn powder		0	12
Powder for the mortar		3	0

Length of the fuze compoſition $\frac{15}{16}$ths of an inch; 2 ounce ſtrung ſtars, 34; rolled ſtars, as many as the ſhell will contain, allowing room for the fuze.

Royal balloons of ſerpents.

		oz.	dr.
Meal powder		1	0
Corn powder		1	8
Powder for the mortar		3	8

Length of the fuze compoſition 1 inch: 1 ounce-caſes drove $3\frac{1}{2}$ and 4 diameters, and bounced 2, of each an equal quantity, ſufficient to load the ſhell.

Royal balloons with crackers and marrons.

		oz.	dr.
Meal powder		1	8
Corn powder		1	4
Powder for firing the mortar		3	0

Length of the fuze compoſition $\frac{14}{16}$ths of an inch; reports 12, and completed with crackers of 8 bounces.

Compound royal balloons.

		oz.	dr.
Meal powder		1	5
Corn powder		1	6
Powder for the mortar		3	12

Length of the fuze compoſition 1 inch: $\frac{1}{2}$ ounce caſes drove and bounced 2 diameters, 8; 2 ounce caſes filled $\frac{3}{8}$ths of an inch with ſtar compoſition, and bounced 2 diameters, 8; ſilver rain-falls, 10; 2 ounce tailed ſtars, 16; rolled brilliant ſtars, 30. If this ſhould not be ſufficient to load the ſhell, you may complete it with gold rain-falls.

Eight-inch balloons illuminated.

		oz.	dr.
Meal powder		2	8
Corn powder		1	4
Powder for the mortar		9	0

Length of the fuze compoſition 1 inch $\frac{1}{8}$th: 2 ounce drove ſtars, 48; 2 ounce caſes drove with ſtar compoſition $\frac{1}{8}$ths of an inch, and bounced 3 diameters, 12; and the balloon completed with 2 ounce drove brilliant ſtars.

Eight-inch balloons of ſerpents.

		oz.	dr.
Meal powder		2	0
Corn powder		2	0
Powder for the mortar		9	8

Length of the fuze compoſition 1 inch $\frac{3}{16}$ths: 2 oz. caſes drove $1\frac{1}{2}$ diameter and bounced 2, and 1 ounce caſes drove 2 diameters and bounced $2\frac{1}{2}$, of each an equal quantity ſufficient for the ſhell.

N. B. The ſtar-compoſition drove in bounced caſes muſt be managed thus: Firſt, the caſes muſt be pinched cloſe at one end, then the corn-powder put in for a report, and the caſe pinched again cloſe to the powder, only leaving a ſmall vent for the ſtar compoſition, which is drove at top, to communicate to the powder at the bounce end.

Compound eight-inch balloons.

		oz.	dr.
Meal powder		2	8
Corn powder		1	12
Powder for the mortar		9	4

Length of the fuze compoſition $\frac{1}{8}$th: 4 ounce caſes drove with ſtar compoſition $\frac{1}{8}$ths of an inch, and bounced 3 diameters, 16; 2 ounce tailed ſtars, 16; 2 ounce drove brilliant ſtars, 12; ſilver rain-falls, 20; 1 ounce drove blue ſtars, 20; and 1 ounce caſes drove and bounced 2 diameters, as many as will fill the ſhell.

Air-balloons, &c.

Another of eight inches.

		oz.	dr.
Meal powder		2	8
Corn powder		1	12
Powder for the mortar		9	4

Length of the fuze compoſition 1 inch $\frac{1}{8}$th: crackers of 6 reports, 10; gold rains, 14; 2 ounce caſes drove with ſtar compoſition $\frac{1}{8}$ths of an inch, and bounced 2 diameters, 16; 2 ounce tailed ſtars, 16; 2 ounce drove brilliant ſtars, 12; ſilver rains, 10; 1 ounce drove blue ſtars, 20; and 1 oz. caſes drove with a brilliant charge 2 diameters and bounced 3, as many as the ſhell will hold.

A compound ten-inch balloon.

		oz.	dr.
Meal powder		3	4
Corn powder		2	8
Powder for the mortar		12	8

Length of the fuze compoſition $\frac{15}{16}$ths of an inch: 1 ounce caſes drove and bounced 3 diameters, 16. Crackers of 8 reports, 12; 4 ounce caſes drove $\frac{1}{2}$ inch with ſtar-compoſition, and bounced 2 diameters, 14; 2 ounce caſes drove with brilliant fire $1\frac{1}{4}$ diameter, and bounced 2 diameters, 16: 2 ounce drove brilliant ſtars, 30: 2 ounce drove blue ſtars, 3; gold rains, 20; ſilver rains, 20. After all theſe are put in, fill the remainder of the caſe with tailed and rolled ſtars.

Ten-inch balloons of three charges.

		oz.	dr.
Meal powder		3	0
Corn powder		3	2
Powder for the mortar		13	0

Length of the fuze compoſition 1 inch. The ſhell muſt be loaded with 2 ounce caſes, drove with ſtar compoſition $\frac{1}{4}$th of an inch, and on that 1 diameter of gold fire, then bounced 3 diameters; or with 2 ounce caſes firſt filled 1 diameter with gold fire, then $\frac{1}{4}$th of an inch with ſtar compoſition, and on that $1\frac{1}{4}$th diameter of brilliant fire. Theſe caſes muſt be well ſecured at top of the charge, leſt they ſhould take fire at both ends: but their necks muſt be larger than the common proportion.

57. *To make Balloon Fuzes.*

Fuzes for air-balloons are ſometimes turned out of dry beech, with a cup at top to hold the quick-match, as you ſee in fig. 5. but if made with paſted paper, they will do as well: the diameter of the former for fuzes for coehorn balloons muſt be $\frac{1}{2}$ an inch; for a royal fuze, $\frac{5}{8}$ths of an inch; for an 8-inch fuze, $\frac{3}{4}$ths of an inch; and for a 10-inch fuze, $\frac{7}{8}$ths of an inch. Having rolled your caſes, pinch and tie them almoſt cloſe at one end; then drive them down, and let them dry. Before you begin to fill them, mark on the outſide of the caſe the length of the charge required, allowing for the thickneſs of the bottom; and when you have rammed in the compoſition, take two pieces of quick-match about 6 inches long, and lay one end of each on the charge, and then a little meal-powder, which ram down hard; the looſe ends of the match double up into the top of the fuze, and cover it with a paper cap to keep it dry. When you put the ſhells in the mortars, uncap the fuzes, and pull out the looſe ends of the match, and let them hang on the ſides of the balloons. The uſe of the match is, to receive the fire from the powder in the chamber of the mortar, in order to light the fuze: the ſhell being put in the mortar with the fuze uppermoſt, and exactly in the centre, ſprinkle over it a little meal-powder, and it will be ready to be fired.

Fuzes

Air-balloons, &c.

Fuzes made of wood muſt be longer than thoſe of paper, and not bored quite through, but left ſolid about $\frac{1}{4}$ an inch at bottom; and when you uſe them, ſaw them off to a proper length, meaſuring the charge from the cup at top.

58. *Tourbillons.*

Having filled ſome caſes within about $1\frac{1}{2}$ diameter, drive in a ladleful of clay; then pinch their ends cloſe, and drive them down with a mallet. When done, find the centre of gravity of each caſe; where you nail and tie a ſtick, which ſhould be $\frac{1}{4}$ an inch broad at the middle, and run a little narrower to the ends: theſe ſticks muſt have their ends turned upwards, ſo that the caſes may turn horizontally on their centres: at the oppoſite ſides of the caſes, at each end, bore a hole cloſe to the clay with a gimblet, the ſize of the neck of a common caſe of the ſame nature; from theſe holes draw a line round the caſe, and at the under part of the caſe bore a hole with the ſame gimblet, within $\frac{1}{4}$ diameter of each line towards the centre; then from one hole to the other draw a right line. This line divide into three equal parts; and at X and Y (fig. 6.) bore a hole; then from theſe holes to the other two lead a quick-match, over which paſte a thin paper. Fig. 7. repreſents a tourbillon as it ſhould lie to be fired, with a leader from one ſide-hole A to the other B. When you fire tourbillons, lay them on a ſmooth table, with their ſticks downwards, and burn the leader thro' the middle with a port-fire. They ſhould ſpin three or four ſeconds on the table before they riſe, which is about the time the compoſition will be burning from the ſide-holes to thoſe at bottom.

To tourbillons may be fixed reports in this manner: In the centre of the caſe at top make a ſmall hole, and in the middle of the report make another; then place them together, and tie on the report, and with a ſingle paper ſecure it from fire: this done, your tourbillon is completed. By this method you may fix on tourbillons ſmall cones of ſtars, rains, &c. but be careful not to load them too much. One-eighth of an inch will be enough for the thickneſs of the ſticks, and their length equal to that of the caſes.

59. *To make Mortars to throw Aigrettes, and to load and fire them.*

Mortars to throw aigrettes are generally made of paſteboard, of the ſame thickneſs as balloon mortars, and $2\frac{1}{2}$ diameters long in the inſide from the top of the foot: the foot muſt be made of elm without a chamber, but flat at top, and in the ſame proportion as thoſe for balloon mortars; theſe mortars muſt alſo be bound round with a cord as before-mentioned: ſometimes 8 or 9 of theſe mortars, of about three or four inches diameter, are bound all together, ſo as to appear but one: but when they are made for this purpoſe, the bottom of the foot muſt be of the ſame diameter as the mortars, and only $\frac{1}{4}$ diameter high. Your mortars being bound well together, fix them on a heavy ſolid block of wood. To load theſe mortars, firſt put on the inſide bottom of each a piece of paper, and on it ſpread $1\frac{1}{2}$ oz. of meal and corn powder mixed; then tie your ſerpents up in parcels with quick-match, and put them in the mortar with their mouths downwards; but take care the parcels do not fit too tight in the mortars, and that all the ſerpents have been well primed with powder wetted with ſpirit of wine. On the top of the ſerpents in each mortar lay ſome paper or tow; then carry a leader from one mortar to the other all round, and then from all the outſide mortars into that in the middle: theſe leaders muſt be put between the caſes and the ſides of the mortar, down to the powder at bottom: in the centre of the middle mortar fix a fire-pump, or brilliant fountain, which muſt be open at bottom, and long enough to project out of the mouth of the mortar; then paſte paper on the tops of all the mortars.

Air-balloons, &c

Mortars thus prepared are called a *neſt of ſerpents*, as repreſented by fig. 8. When you would fire theſe mortars, light the fire-pump C, which when conſumed will communicate to all the mortars at once by means of the leaders. For mortars of 6, 8, or 10 inches diameter, the ſerpents ſhould be made in 1 and 2 ounce caſes 6 or 7 inches long, and fired by a leader brought out of the mouth of the mortar, and turned down the outſide, and the end of it covered with paper, to prevent the ſparks of the other works from ſetting it on fire. For a ſix-inch mortar, let the quantity of powder for firing be 2 oz.; for an 8-inch, $2\frac{1}{4}$ oz.; and for a 10-inch, $3\frac{1}{4}$ oz. Care muſt be taken in theſe, as well as ſmall mortars, not to put the ſerpents in too tight, for fear of burſting the mortars. Theſe mortars may be loaded with ſtars, crackers, &c.

If the mortars, when loaded, are ſent to any diſtance, or liable to be much moved, the firing powder ſhould be ſecured from getting amongſt the ſerpents, which would endanger the mortars, as well as hurt their performance. To prevent which, load your mortars thus: Firſt put in the firing powder, and ſpread it equally about; then cut a round piece of blue touch-paper, equal to the exterior diameter of the mortar, and draw on it a circle equal to the interior diameter of the mortar, and notch it all round as far as that circle; then paſte that part which is notched, and put it down the mortar cloſe to the powder, and ſtick the paſted edge to the mortar: this will keep the powder always ſmooth at bottom, ſo that it may be moved or carried anywhere without receiving damage. The large ſingle mortars are called *pots des aigrettes*.

60. *Making, loading, and firing, of Pots des Brins.*

Theſe are formed of paſteboard, and muſt be rolled pretty thick. They are uſually made 3 or 4 inches diameter, and 4 diameters long; and pinched with a neck at one end, like common caſes. A number of theſe are placed on a plank thus: Having fixed on a plank two rows of wooden pegs, cut in the bottom of the plank a groove the whole length under each row of pegs; then, through the centre of each peg, bore a hole down to the groove at bottom, and on every peg fix and glue a pot, whoſe mouth muſt fit tight on the peg: through all the holes run a quick-match, one end of which muſt go into the pot, and the other into the groove, which muſt have a match laid in it from end to end, and covered with paper, ſo that when lighted at one end it may diſcharge the whole almoſt inſtantaneouſly: in all the pots put about 1 oz. of meal and corn powder; then in ſome put ſtars, and others rains, ſnakes, ſerpents, crackers, &c. when they are all loaded, paſte paper over their mouths. Two or three hundred of theſe pots being fired together make a very pretty ſhow, by affording ſo great a variety of fires. Fig. 9. is a range of pots des brins, with a leader A, by which they are fired.

Air-balloons, &c.

61. *Pots des Sauriſſons,*

Are generally fired out of large mortars without chambers, the ſame as thoſe for aigrettes, only ſomewhat ſtronger. Sauciſſons are made of 1 and 2 ounce caſes, 5 or 6 inches long, and choaked in the ſame manner as ſerpents. Half the number which the mortar contains muſt be drove 1½ diameter with compoſition, and the other half two diameters, ſo that when fired they may give two volleys of reports. But if the mortars are very ſtrong, and will bear a ſufficient charge to throw the ſauciſſons very high, you may make three volleys of reports, by dividing the number of caſes into three parts, and making a difference in the height of the charge. After they are filled, pinch and tie them at top of the charge almoſt cloſe; only leaving a ſmall vent to communicate the fire to the upper part of the caſe, which muſt be filled wi h corn-powder very near the top; then pinch the end quite cloſe, and tie it: after this is done, bind the caſe very tight with waxed packthread, from the choak at top of the compoſition to the end of the caſe; this will make the caſe very ſtrong in that part, and cauſe the report to be very loud. Sauciſſons ſhould be rolled a little thicker of paper than the common proportion. When they are to be put in the mortar, they muſt be primed in their mouths, and fired by a caſe of brilliant fire fixed in their centre.

The charge for theſe mortars ſhould be $\frac{1}{6}$th or $\frac{1}{8}$th more than for *pots des aigrettes* of the ſame diameter.

Sect. IV. *Different kinds of Rockets, with their Appendages and Combinations.*

62. *To fix one Rocket on the top of another.*

When ſky-rockets are thus managed, they are called *towering rockets*, on account of their mounting ſo very high. Towering rockets are made after this manner: Fix on a pound-rocket a head without a collar; then take a four ounce rocket, which may be headed or bounced, and rub the mouth of it with meal-powder wetted with ſpirit of wine: when done, put it in the head of the large rocket with its mouth downwards; but before you put it in, ſtick a bit of quick-match in the hole of the clay of the pound-rocket, which match ſhould be long enough to go a little way up the bore of the ſmall rocket, to fire it when the large is burnt out, the 4 ounce rocket being too ſmall to fill the head of the other, roll round it as much tow as will make it ſtand upright in the centre of the head: the rocket being thus fixed, paſte a ſingle paper round the opening of the top of the head of the large rocket. The large rocket muſt have only half a diameter of charge rammed above the piercer; for, if filled to the uſual height, it would turn before the ſmall one takes fire, and entirely deſtroy the intended effect: when one rocket is headed with another, there will be no occaſion for any blowing powder; for the force with which it ſets off will be ſufficient to diſengage it from the head of the firſt fired rocket. The ſticks for theſe rockets muſt be a little longer than for thoſe headed with ſtars, rains, &c.

63. *Caduceus Rockets,*

In riſing, form two ſpiral lines, or double worm, by reaſon of their being placed obliquely, one oppoſite the other; and their counterpoiſe in their centre, which cauſes them to riſe in a vertical direction. Rockets for this purpoſe muſt have their ends choaked cloſe, without either head or bounce, for a weight at top would be a great obſtruction to their mounting; though I have known them ſometimes to be bounced, but then they did not riſe ſo high as thoſe that were not; nor do any caduceus rockets aſcend ſo high as ſingle, becauſe of their ſerpentine motion, and likewiſe the reſiſtance of air, which is much greater than two rockets of the ſame ſize would meet with if fired ſingly. Rockets, &c.

By 2d fig. 9. you ſee the method of fixing theſe rockets: the ſticks for this purpoſe muſt have all their ſides alike, which ſides ſhould be equal to the breadth of a ſtick proper for a ſky-rocket of the ſame weight as thoſe you intend to uſe, and to taper downwards as uſual, long enough to balance them, one length of a rocket from the croſs ſtick; which muſt be placed from the large ſtick 6 diameters of one of the rockets, and its length 7 diameters; ſo that each rocket, when tied on, may form with the large ſtick an angle of 60 degrees. In tying on the rockets, place their heads on the oppoſite ſides of the croſs ſtick, and their ends on the oppoſite ſides of the long ſtick; then carry a leader from the mouth of one into that of the other. When theſe rockets are to be fired, ſuſpend them between two hooks or nails, then burn the leader through the middle, and both will take fire at the ſame time. Rockets of 1 lb. are a good ſize for this uſe.

64. *Honorary Rockets,*

Are the ſame as ſky-rockets, except that they carry no head nor report, but are cloſed at top, on which is fixed a cone; then on the caſe, cloſe to the top of the ſtick, you tie on a 2 ounce caſe, about 5 or 6 inches long, filled with a ſtrong charge, and pinched cloſe at both ends; then in the reverſe ſides, at each end, bore a hole in the ſame manner as in tourbillons; from each hole carry a leader into the top of the rocket. When the rocket is fired, and arrived to its proper height, it will give fire to the caſe at top; which will cauſe both rocket and ſtick to ſpin very faſt in their return, and repreſent a worm of fire deſcending to the ground.

There is another method of placing the ſmall caſe, which is by letting the ſtick riſe a little above the top of the rocket, and tying the caſe to it, ſo as to reſt on the rocket: theſe rockets have no cones.

There is alſo a third method by which they are managed, which is thus: In the top of a rocket fix a piece of wood, in which drive a ſmall iron ſpindle; then make a hole in the middle of the ſmall caſe, through which put the ſpindle: then fix on the top of it a nut, to keep the caſe from falling off; when this is done, the caſe will turn very faſt, without the rocket: but this method does not anſwer ſo well as either of the former.

Fig. 10. is the honorary rocket complete. The beſt ſized rockets for this purpoſe are thoſe of 1 lb.

65. *To divide the tail of a Sky-rocket ſo as to form an Arch when aſcending.*

Having ſome rockets made, and headed according to fancy, and tied on their ſticks; get ſome ſheet tin, and cut it into round pieces about 3 or 4 inches diameter; then on the ſtick of each rocket, under the mouth of the caſe, fix one of theſe pieces of tin 16 inches from the rocket's neck, and ſupport it by a wooden bracket,

as

Rockets, &c.

as ſtrong as poſſible: the uſe of this is, that when the rocket is aſcending the fire will play with great force on the tin, which will divide the tail in ſuch a manner that it will form an arch as it mounts, and will have a very good effect when well managed: if there is a ſhort piece of port-fire, of a ſtrong charge, tied to the end of the ſtick, it will make a great addition; but this muſt be lighted before you fire the rocket.

66. *To make ſeveral Sky-rockets riſe in the ſame direction, and equally diſtant from each other.*

Take ſix, or any number of ſky-rockets, of what ſize you pleaſe, then cut ſome ſtrong packthread into pieces of 3 or 4 yards long, and tie each end of theſe pieces to a rocket in this manner: Having tied one end of your packthread round the body of one rocket, and the other end to another, take a ſecond piece of packthread and make one end of it faſt to one of the rockets already tied, and the other end to a third rocket, ſo that all the rockets, except the two outſide, will be faſtened to two pieces of packthread: the length of thread from one rocket to the other may be what the maker pleaſes; but the rockets muſt be all of a ſize, and their heads filled with the ſame weight of ſtars, rains, &c.

Having thus done, fix in the mouth of each rocket a leader of the ſame length; and when you are going to fire them, hang them almoſt cloſe; then tie the ends of the leaders together, and prime them: this prime being fired, all the rockets will mount at the ſame time, and divide as far as the ſtrings will allow; which diviſion they will keep, provided they are all rammed alike, and well made. They are called by ſome *chained rockets*.

67. *Signal Sky-rockets*

Are made of ſeveral kinds, according to the different ſignals intended to be given; but in artificial fireworks, two ſorts are only uſed, which are one with reports and the other without; but thoſe for the uſe of the navy and army are headed with ſtars, ſerpents, &c. —— Rockets which are to be bounced muſt have their caſes made 1½ or 2 diameters longer than the common proportion; and after they are filled, drive in a double quantity of clay, then bounce and pinch them after the uſual manner, and fix on each a cap.

Signal ſky-rockets without bounces, are only ſky-rockets cloſed and capped: theſe are very light, therefore do not require ſuch heavy ſticks as thoſe with loaded heads; for which reaſon you may cut one length of the rocket off the ſtick, or elſe make them thinner.

Signal rockets with reports are fired in ſmall flights; and often both theſe, and thoſe without reports, are uſed for a ſignal to begin firing a collection of works.

68. *To fix a Sky-rocket with its Stick on the top of another.*

Rockets thus managed make a pretty appearance, by reaſon of a freſh tail being ſeen when the ſecond rocket takes fire, which will mount to a great height. The method of preparing theſe rockets is thus: Having filled a two-pounder, which muſt be filled only half a diameter above the piercer, and its head not more than 10 or 12 ſtars; the ſtick of this rocket muſt be made a little thicker than common; and when made, cut it in half the flat way, and in each half make a groove, ſo that when the two halves are joined, the hollow made by the grooves may be large enough to hold the ſtick of a half-pound rooket; which rocket make and head as uſual: put the ſtick of this rocket into the hollow of the large one, ſo far that the mouth of the rocket may reſt on the head of the two-pounder; from whoſe head carry a leader into the mouth of the ſmall rocket; which being done, your rockets will be ready for firing.

Rockets, &c.

2d 68. *To fix two or more Sky-rockets on one Stick.*

Two, three, or ſix ſky-rockets, fixed on one ſtick, and fired together, make a grand and beautiful appearance; for the tails of all will ſeem but as one of an immenſe ſize, and the breaking of ſo many heads at once, will reſemble the burſting of an air-balloon. The management of this device requires a ſkilful hand; but if the following inſtructions be well obſerved, even by thoſe who have not made a great progreſs in this art, there will be no doubt of the rockets having the deſired effect.

Rockets for this purpoſe muſt be made with the greateſt exactneſs, all rammed by the ſame hand, in the ſame mould, and out of the ſame proportion of compoſition; and after they are filled and headed, muſt all be of the ſame weight. The ſtick muſt alſo be well made (and proportioned) to the following directions: firſt, ſuppoſing your rockets to be ½ pounders, whoſe ſticks are 6 feet 6 inches long, then if 2, 3, or 6 of theſe are to be fixed on 1 ſtick, let the length of it be 9 feet 9 inches; then cut the top of it into as many ſides as there are rockets, and let the length of each ſide be equal to the length of 1 of the rockets without its head; and in each ſide cut a groove (as uſual); then from the grooves plane it round, down to the bottom, where its thickneſs muſt be equal to half the top of the round part. As their thickneſs cannot be exactly aſcertained, we ſhall give a rule which generally anſwers for any number of rockets above two: the rule is this; that the ſtick at top muſt be thick enough, when the grooves are cut, for all the rockets to lie, without preſſing each other, though as near as poſſible.

When only 2 rockets are to be fixed on one ſtick, let the length of the ſtick be the laſt given proportion, but ſhaped after the common method, and the breadth and thickneſs double the uſual dimenſions. The point of poiſe muſt be in the uſual place (let the number of rockets be what they will): if ſticks made by the above directions ſhould be too heavy, plane them thinner; and if too light, make them thicker; but always make them of the ſame length.

When more than two rockets are tied on one ſtick, there will be ſome danger of their flying up without the ſtick, unleſs the following precaution is taken: For caſes being placed on all ſides, there can be no notches for the cord which ties on the rockets to lie in; therefore, inſtead of notches, drive a ſmall nail in each ſide of the ſtick, between the necks of the caſes: and let the cord, which goes round their necks, be brought cloſe under the nails; by this means the rockets will be as ſecure as when tied on ſingly. Your rockets being thus fixed, carry a quick-match, without a pipe, from the mouth of one rocket to the other; this match being lighted will give fire to all at once.

Though the directions already given may be ſufficient for theſe rockets, we ſhall here add an improvement on a very eſſential part of this device, which is, that of hanging the rockets to be fired; for before the

Rockets, &c.

following method was hit upon, many eſſays proved unſucceſsful. Inſtead, therefore, of the old and common manner of hanging them on nails or hooks, make uſe of this contrivance: Have a ring made of ſtrong iron wire, large enough for the ſtick to go in as far as the mouths of the rockets; then let this ring be ſupported by a ſmall iron, at ſome diſtance from the poſt or ſtand to which it is fixed; then have another ring, fit to receive and guide the ſmall end of the ſtick. Rockets thus ſuſpended will have nothing to obſtruct their fire; but when they are hung on nails or hooks, in ſuch a manner that ſome of their mouths are againſt or upon a rail, there can be no certainty of their riſing in a vertical direction.

69. *To fire Sky-rockets without Sticks.*

You muſt have a ſtand, of a block of wood, a foot diameter, and make the bottom flat, ſo that it may ſtand ſteady: in the centre of the top of this block draw a circle $2\frac{1}{2}$ inches diameter, and divide the circumference of it into three equal parts; then take 3 pieces of thick iron wire, each about 3 feet long, and drive them into the block, 1 at each point made on the circle; when theſe wires are drove in deep enough to hold them faſt and upright, ſo that the diſtance from one to the other is the ſame at top as at bottom, the ſtand is complete.

The ſtand being thus made, prepare your rockets thus: Take ſome common ſky-rockets, of any ſize, and head them as you pleaſe; then get ſome balls of lead, and tie to each a ſmall wire 2 or $2\frac{1}{2}$ feet long, and the other end of each wire tie to the neck of a rocket. Theſe balls anſwer the purpoſe of ſticks when made of a proper weight, which is about 2-3ds the weight of the rocket; but when they are of a proper ſize, they will balance the rocket in the ſame manner as a ſtick, at the uſual point of poiſe. To fire theſe, hang them, one at a time, between the tops of the wires, letting their heads reſt on the point of the wires, and the balls hang down between them: if the wires ſhould be too wide for the rockets, preſs them together till they fit; and if too cloſe, force them open; the wires for this purpoſe muſt be ſoftened, ſo as not to have any ſpring, or they will not keep their poſition when preſſed cloſe or opened.

70. *Rain-falls and Stars for Sky-rockets, Double and Single.*

Gold and ſilver rain compoſitions are drove in caſes that are pinched quite cloſe at one end: if you roll them dry, 4 or 5 rounds of paper will be ſtrong enough; but if they are paſted, 3 rounds will do; and the thin ſort of cartridge-paper is beſt for thoſe ſmall caſes, which in rolling you muſt not turn down the inſide edge as in other caſes, for a double edge would be too thick for ſo ſmall a bore. The moulds for rain-falls ſhould be made of braſs, and turned very ſmooth in the inſide; or the caſes, which are ſo very thin, would tear in coming out; for the charge muſt be drove in tight; and the better the caſe fits the mould, the more driving it will bear. Theſe moulds have no nipple, but inſtead thereof they are made flat. As it would be very tedious and troubleſome to ſhake the compoſition out of ſuch ſmall ladles as are uſed for theſe caſes, it will be neceſſary to have a funnel made of thin tin, to fit on the top of the caſe, by the help of which you may fill them very faſt. For ſingle rain-falls for 4 oz. rockets, let the diameter of the former be 2-16ths of an inch, and the length of the caſe 2 inches; for 8 oz. rockets, 4-16ths and 2 diameters of the rocket long; for 1 lb. rockets, 5-16ths, and 2 diameters of the rocket long; for 2 lb. rockets, 5-16ths, and $3\frac{1}{2}$ inches long; for 4 lb. rockets, 6-16ths, and $4\frac{1}{2}$ inches long; and for 6-pounders, 7-16ths diameter, and 5 inches long.

Rockets, &c.

Of double rain-falls there are two ſorts. For example, ſome appear firſt like a ſtar, and then as rain; and ſome appear firſt as rain, and then like a ſtar. When you would have ſtars firſt, you muſt fill the caſes, within $\frac{1}{2}$ inch of the top, with rain-compoſition, and the remainder with ſtar-compoſition; but when you intend the rain ſhould be firſt, drive the caſe $\frac{1}{2}$ an inch with ſtar-compoſition, and the reſt with rain. By this method may be made many changes of fire; for in large rockets you may make them firſt burn as ſtars, then rain, and again as ſtars; or they may firſt ſhow rain, then ſtars, and finiſh with a report; but when they are thus managed, cut open the firſt rammed end, after they are filled and bounced, at which place prime them. The ſtar-compoſition for this purpoſe muſt be a little ſtronger than for rolled ſtars.

Strung ſtars. Firſt take ſome thin paper, and cut it into pieces of $1\frac{1}{2}$ inch ſquare, or thereabouts; then on each piece lay as much dry ſtar-compoſition as you think the paper will eaſily contain; then twiſt up the paper as tight as you can; when done, rub ſome paſte on your hands, and roll the ſtars between them; then ſet them to dry: your ſtars being thus made, get ſome flax or fine tow, and roll a little of it over each ſtar; then paſte your hands and roll the ſtars as before, and ſet them again to dry; when they are quite dry, with a piercer make a hole through the middle of each, into which run a cotton quick-match, long-enough to hold 10 or 12 ſtars at 3 or 4 inches diſtance: but any number of ſtars may be ſtrung together by joining the match.

Tailed ſtars. Theſe are called *tailed ſtars*, becauſe there are a great number of ſparks iſſue from them, which repreſent a tail like that of a comet. Of theſe there are two ſorts; which are *rolled*, and *drove*: when rolled, they muſt be moiſtened with a liquor made of half a pint of ſpirit of wine and half a gill of thin ſize, of this as much as will wet the compoſition enough to make it roll eaſy; when they are rolled, ſift meal-powder over them, and ſet them to dry.

When tailed ſtars are drove, the compoſition muſt be moiſtened with ſpirit of wine only, and not made ſo wet as for rolling: 1 and 2 oz. caſes, rolled dry, are beſt for this purpoſe; and when they are filled, unroll the caſe within 3 or 4 rounds of the charge, and all that you unroll cut off; then paſte down the looſe edge: 2 or 3 days after the caſes are filled, cut them in pieces 5 or 6-8ths of an inch in length: then melt ſome wax, and dip one end of each piece into it, ſo as to cover the compoſition: the other end muſt be rubbed with meal-powder wetted with ſpirit of wine.

Drove ſtars. Caſes for drove ſtars are rolled with paſte, but are made very thin of paper. Before you begin to fill them, damp the compoſition with ſpirit of wine that has had ſome camphor diſſolved in it: you may ram them indifferently hard, ſo that you do not break or ſack the caſe; to prevent which, they

ſhould

Rockets, &c.

should fit tight in the mould. They are drove in cases of several sizes, from 8 drams to 4 oz. When they are filled in ½ oz. cases, cut them in pieces of ¾ of an inch long; if 1 oz. cases, cut them in pieces of 1 inch; if 2 oz. cases, cut them in pieces of 1¼ inch long; and if 4 oz. cases, cut them in pieces of 1½ inch long: having cut your stars of a proper size, prime both ends with wet meal-powder. These stars are seldom put in rockets, they being chiefly intended for air-balloons, and drove in cases, to prevent the composition from being broke by the force of the blowing powder in the shell.

Rolling stars are commonly made about the size of a musket-ball; though they are rolled of several sizes, from the bigness of a pistol-ball to 1 inch diameter; and sometimes very small, but are then called *sparks*. Great care must be taken in making stars, first, that the several ingredients are reduced to a fine powder; secondly, that the composition is well worked and mixed. Before you begin to roll, take about a pound of composition, and wet it with the following liquid, enough to make it stick together and roll easy: Spirit of wine 1 quart, in which dissolve ¼ of an ounce of isinglass. If a great quantity of composition be wetted at once, the spirit will evaporate, and leave it dry, before you can roll it into stars: having rolled up one proportion, shake the stars in meal-powder, and set them to dry, which they will do in 3 or 4 days; but if you should want them for immediate use, dry them in an earthen pan over a slow heat, or in an oven. It is very difficult to make the stars all of an equal size when the composition is taken up promiscuously with the fingers; but by the following method they may be made very exact: When the mixture is moistened properly, roll it on a flat smooth stone, and cut it into square pieces, making each square large enough for the stars you intend. There is another method used by some to make stars, which is by rolling the composition in long pieces, and then cutting off the star, so that each star will be of a cylindrical form: but this method is not so good as the former; for, to make the composition roll this way, it must be made very wet, which makes the stars heavy, as well as weakens them. All stars must be kept as much from air as possible, otherwise they will grow weak and bad.

71. *Scrolls for Sky-rockets.*

Cases for scrolls should be made 4 or 5 inches in length, and their interior diameter 3-8ths of an inch: one end of these cases must be pinched quite close, before you begin to fill; and when filled, close the other end: then in the opposite sides make a small hole at each end, to the composition, in the same manner as in tourbillons; and prime them with wet meal-powder. You may put in the head of a rocket as many of these cases as it will contain: being fired they turn very quick in the air, and form a scroll or spiral line. They are generally filled with a strong charge, as that of serpents or brilliant fire.

72. *Swarmers, or small Rockets.*

Rockets that go under the denomination of *swarmers*, are those from 2 oz. downwards. These rockets are fired sometimes in flights, and in large water-works, &c. Swarmers of 1 and 2 oz. are bored, and made in the same manner as large rockets, except that, when headed, their heads must be put on without a collar: the number of strokes for driving 1 oz. must be 8, and for 2 oz. 12.

Rockets, &c.

All rockets under 1 oz. are not bored, but must be filled to the usual height with composition, which generally consists of fine meal-powder 4 oz. and charcoal or steel-dust 2 drams: the number of strokes for ramming these small swarmers is not material, provided they are rammed true, and moderately hard. The necks of unbored rockets must be in the same proportion as in common cases.

73. *Stands for Sky-rockets.*

Care must be taken, in placing the rockets when they are to be fired, to give them a vertical direction at their first setting out; which may be managed thus. Have two rails of wood, of any length, supported at each end by a perpendicular leg, so that the rails be horizontal, and let the distance from one to the other be almost equal to the length of the sticks of the rockets intended to be fired; then in the front of the top rail drive square hooks at 8 inches distance, with their points turning sidewise, so that when the rockets are hung on them, the points will be before the sticks and keep them from falling or being blown off by the wind: in the front of the rail at bottom must be staples, drove perpendicular under the hooks at top; through these staples put the small ends of the rocket-sticks. Rockets are fired by applying a lighted port-fire to their mouths.

N. B. When sky-rockets are made to perfection, and fired, they will stand 2 or 3 seconds on the hook before they rise, and then mount up briskly, with a steady motion, carrying a large tail from the ground all the way up, and just as they turn break and disperse the stars.

74. *Girandole Chests for Flights of Rockets.*

These are generally composed of four sides, of equal dimensions; but may be made of any diameter, according to the number of rockets designed to be fired; its height must be in proportion to the rockets, but must always be a little higher than the rockets with their sticks. When the sides are joined, fix in the top, as far down the chest as the length of one of the rockets with its cap on. In this top, make as many square or round holes to receive the rocket-sticks, as you intend to have rockets; but let the distance between them be sufficient for the rockets to stand without touching one another; then from one hole to another cut a groove large enough for a quick-match to lie in: the top being thus fixed, put in the bottom, at about 1½ foot distance from the bottom of the chest; in this bottom must be as many holes as in the top, and all to correspond; but these holes need not be so large as those in the top.

To prepare your chest, you must lay a quick-match, in all the grooves, from hole to hole; then take some sky-rockets, and rub them in the mouth with wet meal-powder, and put a bit of match up the cavity of each; which match must be long enough to hang a little below the mouth of the rocket. Your rockets and chest being prepared according to the above directions, put the sticks of the rockets through the holes in the top and bottom of the chest, so that their mouths may rest on the quick-match in the grooves: by which all the rockets will be fired at once; for by giving fire to any

Rockets, &c.

part of the match, it will communicate to all the rockets in an inſtant. As it would be rather troubleſome to direct the ſticks from the top to the proper holes in the bottom, it will be neceſſary to have a ſmall door in one of the ſides, which, when opened, you may ſee how to place the ſticks. Flights of rockets being ſeldom ſet off at the beginning of any fire-works, they are in danger of being fired by the ſparks from wheels, &c. therefore, to preſerve them, a cover ſhould be made to fit on the cheſt, and the door in the ſide kept ſhut.

75. *Serpents or Snakes for Pots of Aigrettes, ſmall Mortars, Sky-rockets, &c.*

Serpents for this uſe are made from 2½ inches to 7 inches long, and their formers from 3-16ths to 5-8ths of an inch diameter; but the diameter of the caſes muſt always be equal to 2 diameters of the former. They are rolled and choaked like other caſes, and filled with compoſition from 5-8ths of an inch to 1½ inch high, according to the ſize of the mortars or rockets they are deſigned for; and the remainder of the caſes bounced with corn-powder, and afterwards their ends pinched and tied cloſe: before they are uſed, their mouths muſt be primed with wet meal-powder.

76. *Leaders, or Pipes of Communication.*

The beſt paper for leaders is elephant; which you cut into long ſlips 2 or 3 inches broad, ſo that they may go 3 or 4 times round the former, but not *more*: when they are very thick, they are too ſtrong for the paper which faſtens them to the works, and will ſometimes fly off without leading the fire. The formers for theſe leaders are made from 2 to 6-16ths of an inch diameter; but 4-16ths is the ſize generally made uſe of. The formers are made of ſmooth braſs wire: when you uſe them, rub them over with greaſe, or keep them wet with paſte, to prevent their ſticking to the paper, which muſt be paſted all over. In rolling of pipes, make uſe of a rolling-board, but uſe it lightly: having rolled a pipe, draw out the former with one hand, holding the pipe as light as poſſible with the other; for if it preſs againſt the former, it will ſtick and tear the paper.

N. B. Make your leaders of different lengths, or in clothing of works you will cut a great many to waſte. Leaders for marron batteries muſt be made of ſtrong cartridge paper.

77. *Crackers.*

Cut ſome cartridge paper into pieces 3½ inches broad, and one foot long; one edge of each fold down lengthwiſe about ¼ of an inch broad; then fold the double edge down ¼ of an inch, and turn the ſingle edge back half over the double fold; then open it, and lay all along the channel, which is formed by the folding of the paper, ſome meal-powder; then fold it over and over till all the paper is doubled up, rubbing it down every turn; this done, bend it backwards and forwards, 2½ inches, or thereabouts, at a time, as oft as the paper will allow; then hold all theſe folds flat and cloſe, and with a ſmall pinching cord give one turn round the middle of the cracker, and pinch it cloſe; then bind it with a packthread as tight as you can; then, in the place where it was pinched, prime one end of it, and cap it with touch-paper. When theſe crackers are fired, they will give a report at every turn of the paper: if you would have a great number of bounces, you muſt cut the paper longer, or join them after they are made; but if they are made very long before they are pinched, you muſt have a piece of wood with a groove in it, deep enough to let in half the cracker; this will hold it ſtraight while it is pinching. Fig. 12. repreſents a cracker complete.

Rockets, &c.

78. *Single Reports.*

Caſes for reports are generally rolled on one and two oz. formers, and ſeldom made larger but on particular occaſions; they are made from two to four inches long, and very thick of paper. Having rolled a caſe, pinch one end quite cloſe, and drive it down: then fill the caſe with corn-powder, only leaving room to pinch it at top; but before you pinch it, put in a piece of paper at top of the powder. Reports are fired by a vent, bored in the middle, or at one end, juſt as required.

79. *Marrons.*

Formers for marrons are from ¾ of an inch to 1½ diameter. Cut the paper for the caſes twice the diameter of the former broad, and long enough to go three times round: when you have rolled a caſe, paſte down the edge and tie one end cloſe; then with the former drive it down to take away the wrinkles, and make it flat at bottom; then fill the caſe with corn-powder one diameter and ¼ high, and fold down the reſt of the caſe tight on the powder. The marron being thus made, wax ſome ſtrong pack-thread with ſhoemakers wax; this thread wind up in a ball, then unwind two or three yards of it, and that part which is near the ball make faſt to a hook; then take a marron, and ſtand as far from the hook as the pack-thread will reach, and wind it lengthwiſe round the marron as cloſe as you can, till it will hold no more that way; then turn it, and wind the packthread on the ſhort way, then lengthwiſe again, and ſo on till the paper is all covered; then make faſt the end of the packthread, and beat down both ends of the marron to bring it in ſhape. The method of firing marrons is by making a hole at one end with an awl, and putting in a piece of quick-match; then take a piece of ſtrong paper, in which wrap up the marron with two leaders, which muſt be put down to the vent, and the paper tied tight round them with ſmall twine: theſe leaders are bent on each ſide, and their looſe ends tied to other marrons, and are nailed in the middle to the rail of the ſtand, as in fig. 13. The uſe of winding the packthread in a ball is, that you may let it out as you want it, according to the quantity the marron may require; and that it may not be tied in knots, which would ſpoil the marron.

80. *Marron Batteries,*

If well managed, will keep time to a march, or a ſlow piece of muſic. Marron batteries are made of ſeveral ſtands, with a number of croſs rails for the marrons; which are regulated by leaders, by cutting them of different lengths, and nailing them tight, or looſe, according to the time of the muſic. In marron batteries you muſt uſe the large and ſmall marrons, and the nails for the pipes muſt have flat heads.

81. *Line Rockets.*

Are made and drove as the ſky-rockets, but have no heads, and the caſes muſt be cut cloſe to the clay: they are ſometimes made with ſix or ſeven changes, but in general not more than four or five. The method of managing thoſe rockets is thus: Firſt, have a piece of light wood, the length of one of the rockets, turned round

Rockets, &c.

round about 2½ inches diameter, with a hole through the middle lengthwiſe, large enough for the lime to go eaſily through: if you deſign four changes, have four grooves cut in the ſwivel, one oppoſite the other, to lay the rockets in.

The mouths of the rockets being rubbed with wet meal-powder, lay them in the grooves head to tail, and tie them faſt; from the tail of the firſt rocket carry a leader to the mouth of the ſecond, and from the ſecond to the third, and ſo on to as many as there are on the ſwivel, making every leader very ſecure; but in fixing theſe pipes, take care that the quick-match does not enter the bores of the rockets: the rockets being fixed on the ſwivel and ready to be fired, have a line 100 yards long, ſtretched and fixed up tight, at any height from the ground; but be ſure to place it horizontally: this length of line will do for ½lb. rockets; but if larger, the line muſt be longer. Before you put up the line, put one end of it through the ſwivel; and when you fire the line rocket, let the mouth of that rocket which you fire firſt face that end of the line where you ſtand; then the firſt rocket will carry the reſt to the other end of the line, and the ſecond will bring them back; and ſo they will run out and in according to the number of rockets: at each end of the line there muſt be a piece of flat wood for the rocket to ſtrike againſt, or its force will cut the line. Let the line be well ſoaped, and the hole in the ſwivel very ſmooth.

82. *Different Decorations for Line Rockets.*

To line rockets may be fixed great variety of figures, ſuch as flying dragons, Mercuries, ſhips, &c. Or they may be made to run on the line like a wheel; which is done in this manner. Have a flat ſwivel made very exact, and on it tie two rockets obliquely, one on each ſide, which will make it turn round all the way it goes, and form a circle of fire; the charge for theſe rockets ſhould be a little weaker than common. If you would ſhow two dragons fighting, get two ſwivels made ſquare, and on each tie three rockets together on the under ſide; then have two flying dragons made of tin, and fix one of them on the top of each ſwivel, ſo as to ſtand upright; in the mouth of each dragon put a ſmall caſe of common fire, and another at the end of the tail; you may put two or three port-fires, of a ſtrong charge, on one ſide of their bodies, to ſhow them. This done, put them on the line, one at each end; but let there be a ſwivel in the middle of the line to keep the dragons from ſtriking together: before you fire the rockets, light the caſes on the dragons; and if care be taken in firing both at the ſame time, they will meet in the middle of the line, and ſeem to fight. Then they will run back and return with great violence; which will have a very pleaſing effect. The line for theſe rockets muſt be very long, or they will ſtrike too hard together.

83. *Chineſe Flyers.*

Caſes for flyers may be made of different ſizes, from one to eight ounces: they muſt be made thick of paper, and eight interior diameters long; they are rolled in the ſame manner as tourbillons, with a ſtraight paſted edge, and pinched cloſe at one end. The method of filling them is, the caſe being put in a mould, whoſe cylinder, or foot, muſt be flat at top without a nipple, fill it within ½ a diameter of the middle; then ram in ½ a diameter of clay, on that as much compoſition as before, on which drive ½ a diameter of clay; then pinch the caſe cloſe, and drive it down flat: after this is done, bore a hole exactly through the centre of the clay in the middle; then in the oppoſite ſides, at both ends, make a vent; and in that ſide you intend to fire firſt make a ſmall hole to the compoſition near the clay in the middle, from which carry a quick-match, covered with a ſingle paper, to the vent at the other end; then, when the charge is burnt on one ſide, it will, by means of the quick-match, communicate to the charge on the other (which may be of a different ſort). The flyers being thus made, put an iron pin, that muſt be fixed in the work on which they are to be fired, and on which they are to run, through the hole in the middle; on the end of this pin muſt be a nut to keep the flyer from running off. If you would have them turn back again after they are burnt, make both the vents at the ends on the ſame ſide, which will alter its courſe the contrary way.

Rockets, &c.

84. *Table Rockets,*

Are deſigned merely to ſhow the truth of driving, and the judgment of a fire-worker, they having no other effect, when fired, than ſpinning round in the ſame place where they begin, till they are burnt out, and ſhowing nothing more than an horizontal circle of fire.

The method of making theſe rockets is—Have a cone turned out of hard wood 2½ inches diameter, and as much high; round the baſe of it draw a line; on this line fix four ſpokes, two inches long each, ſo as to ſtand one oppoſite the other; then fill four nine-inch one lb caſes with any ſtrong compoſition, within two inches of the top: theſe caſes are made like tourbillons, and muſt be rammed with the greateſt exactneſs.

Your rockets being filled, fix their open ends on the ſhort ſpokes; then in the ſide of each caſe bore a hole near the clay; all theſe holes, or vents, muſt be ſo made that the fire of each caſe may act the ſame way; from theſe vents carry leaders to the top of the cone, and tie them together. When you would fire the rockets, ſet them on a ſmooth table, and light the leaders in the middle, and all the caſes will fire together (ſee fig. 14.) and ſpin on the point of the cone.

Plate ccccxxxix

Theſe rockets may be made to riſe like tourbillons, by making the caſes ſhorter, and boring four holes in the under ſide of each at equal diſtances: this being done, they are called *double tourbillons.*

Note, All the vents in the under ſide of the caſes muſt be lighted at once; and the ſharp point of the cone cut off, at which place make it ſpherical.

SECT. V. *Of Wheels and other Works.*

85. *Single Vertical Wheels.*

THERE are different ſorts of vertical wheels; ſome having their fells of a circular form, others of an hexagon, octagon, or decagon form, or any number of ſides, according to the length of the caſes you deſign for the wheel: your ſpokes being fixed in the nave, nail ſlips of tin, with their edges turned up, ſo as to form grooves for the caſes to lie in, from the end of one ſpoke to another; then tie your caſes in the grooves head to tail, in the ſame manner as thoſe on the horizontal water-wheel, ſo that the caſes ſucceſſively taking fire from one another, will keep the wheel in an equal rotation. Two of theſe wheels are very oft fired together, one on each

Of Wheels, &c.

fide of a building; and both lighted at the ſame time, and all the caſes filled alike, to make them keep time together; which they will do if made by the following directions. In all the caſes of both wheels, except the firſt, on each wheel drive two or three ladles full of ſlow fire, in any part of the caſes; but be careful to ram the ſame quantity in each caſe, and in the end of one of the caſes, on each wheel, you may ram one ladlefull of dead-fire compoſition, which muſt be very lightly drove; you may alſo make many changes of fire by this method.

Let the hole in the nave of the wheel be lined with braſs, and made to turn on a ſmooth iron ſpindle. On the end of this ſpindle let there be a nut, to ſcrew off and on; when you have put the wheel on the ſpindle, ſcrew on the nut, which will keep the wheel from flying off. Let the mouth of the firſt caſe be a little raiſed. See fig. 15. Vertical wheels are made from 10 inches to 3 feet diameter, and the ſize of the caſes muſt differ accordingly; 4-oz. caſes will do for wheels of 14 or 16 inches diameter, which is the proportion generally uſed. The beſt wood for wheels of all ſorts is a light and dry beech.

86. *Horizontal Wheels*,

Are beſt when their fells are made circular; in the middle of the top of the nave muſt be a pintle, turned out of the ſame piece as the nave, two inches long, and equal in diameter to the bore of one of the caſes of the wheel: there muſt be a hole bored up the centre of the nave, within half an inch of the top of the pintle. The wheel being made, nail at the end of each ſpoke (of which there ſhould be ſix or eight) a piece of wood, with a groove cut in it to receive the caſe. Fix theſe pieces in ſuch a manner that half the caſes may incline upwards and half downwards, and that, when they are tied on, their heads and tails may come very near together; from the tail of one caſe to the mouth of the other carry a leader, which ſecure with paſted paper. Beſides theſe pipes, it will be neceſſary to put a little meal-powder inſide the paſted paper, to blow off the pipe, that there may be no obſtruction to the fire from the caſes. By means of theſe pipes the caſe will ſucceſſively take fire, burning one upwards and the other downwards. On the pintle fix a caſe of the ſame ſort as thoſe on the wheel; this caſe muſt be fired by a leader from the mouth of the laſt caſe on the wheel, which caſe muſt play downwards: inſtead of a common caſe in the middle, you may put a caſe of Chineſe fire, long enough to burn as long as two or three of the caſes on the wheel.

Horizontal wheels are oft fired two at a time, and made to keep time like vertical wheels, only they are made without any ſlow or dead fire; 10 or 12 inches will be enough for the diameter of wheels with ſix ſpokes. Fig. 16. repreſents a wheel on fire, with the firſt caſe burning.

87. *Spiral Wheels*,

Are only double horizontal wheels, and made thus: The nave muſt be about 6 inches long, and ſomewhat thicker than the ſingle ſort; inſtead of the pintle at top, make a hole for the caſe to be fixed in, and two ſets of ſpokes, one ſet near the top of the nave, and the other near the bottom. At the end of each ſpoke cut a groove wherein you tie the caſes, there being no fell; the ſpokes ſhould not be more than $3\frac{1}{2}$ inches long from the nave, ſo that the wheel may not be more than 8 or 9 inches diameter; the caſes are placed in ſuch a manner, that thoſe at top play down, and thoſe at bottom play up, but let the third or fourth caſe play horizontally. The caſe in the middle may begin with any of the others you pleaſe: 6 ſpokes will be enough for each ſet, ſo that the wheel may conſiſt of 12 caſes, beſides that on the top: the caſes 6 inches each.

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88. *Plural Wheels*,

Are made to turn horizontally, and to conſiſt of three ſets of ſpokes, placed 6 at top, 6 at bottom, and 4 in the middle, which muſt be a little ſhorter than the reſt: let the diameter of the wheel be 10 inches; the caſes muſt be tied on the ends of the ſpokes in grooves cut on purpoſe, or in pieces of wood nailed on the ends of the ſpokes, with grooves cut in them as uſual: in cloathing theſe wheels, make the upper ſet of caſes play obliquely downwards, the bottom ſet obliquely upwards, and the middle ſet horizontally. In placing the leaders, you muſt order it ſo that the caſes may burn thus, viz. firſt up, then down, then horizontal, and ſo on with the reſt. But another change may be made, by driving in the end of the 8th caſe two or three ladlefuls of ſlow fire, to burn till the wheel has ſtopped its courſe; then let the other caſes be fixed the contrary way, which will make the wheel run back again: for the caſe at top you may put a ſmall gerbe; and let the caſes on the ſpokes be ſhort, and filled with a ſtrong brilliant charge.

89. *Illuminated Spiral Wheel.*

Firſt have a circular horizontal wheel made two feet diameter, with a hole quite through the nave; then take three thin pieces of deal, three feet long each, and $\frac{1}{4}$ of an inch broad each: one end of each of theſe pieces nail to the fell of the wheel, at an equal diſtance from one another, and the other end nail to a block with a hole in its bottom, which muſt be perpendicular with that in the block of the wheel, but not ſo large. The wheel being thus made, have a hoop planed down very thin and flat; then nail one end of it to the fell of the wheel, and wind it round the three ſticks in a ſpiral line from the wheel to the block at top: on the top of this block fix a caſe of Chineſe fire; on the wheel you may place any number of caſes, which muſt incline downwards, and burn two at a time. If the wheel ſhould conſiſt of 10 caſes, you may let the illuminations and Chineſe fire begin with the ſecond caſes. The ſpindle for this wheel muſt be a little longer than the cone, and made very ſmooth at top, on which the upper block is to turn, and the whole weight of the wheel to reſt. See fig. 17.

90. *Double Spiral Wheel.*

For this wheel the block, or nave, muſt be as long as the height of the worms, or ſpiral lines, but muſt be made very thin, and as light as poſſible. In this block muſt be fixed ſeveral ſpokes, which muſt diminiſh in length, from the wheel to the top, ſo as not to exceed the ſurface of a cone of the ſame height. To the ends of theſe ſpokes nail the worms, which muſt croſs each other ſeveral times: theſe worms clothe with illuminations, the ſame as thoſe on the ſingle wheels; but the horizontal wheel you may clothe as you like. At top of the worm place a caſe of ſpur-fire, or an amber light. See fig. 18. This figure is ſhown without leaders, to prevent a confuſion of lines.

91. *Balloon Wheels*,

Are made to turn horizontally: they muſt be made 2 feet

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2 feet diameter, without any ſpokes; and very ſtrong, with any number of ſides. On the top of a wheel range and fix in pots, 3 inches diameter and 7 inches high each, as many of theſe as there are caſes on the wheel: near the bottom of each pot make a ſmall vent; into each of theſe vents carry a leader from the tail of each caſe; ſome of the pots load with ſtars, and ſome with ſerpents, crackers, &c. As the wheels turn, the pots will ſucceſſively be fired, and throw into the air a great variety of fires.

92. *Fruiloni Wheels.*

Firſt have a nave made 9 inches long and 3 in diameter: near the bottom of this nave fix 8 ſpokes, with a hole in the end of each, large enough to receive a 2 or 4 ounce caſe: each of theſe ſpokes may be 14 inches long from the block. Near the top of this block fix 8 more of the ſame ſpokes, exactly over the others, but not ſo long by 2 inches. As this wheel is to run horizontally, all the caſes in the ſpokes muſt play obliquely upwards, and all thoſe in the ſpokes at bottom obliquely downwards. This being done, have a ſmall horizontal wheel made with 8 ſpokes, each 5 inches long from the block: on the top of this wheel place a caſe of brilliant fire: all the caſes on this wheel muſt play in an oblique direction downwards, and burn 2 at a time, and thoſe on the large wheel 4 at a time; that is, 2 of thoſe in the top ſet of ſpokes, and 2 of thoſe in the bottom ſet of ſpokes.

The 4 firſt caſes on the large wheel, and the 2 firſt on the ſmall, muſt be fired at the ſame time, and the brilliant fire at top at the beginning of the laſt caſes. The caſes of the wheels may be filled with a grey charge. When theſe wheels are completed, you muſt have a ſtrong iron ſpindle, made 4 feet 6 inches long, and fixed perpendicularly on the top of a ſtand: on this put the large wheel, whoſe nave muſt have a hole quite through from the bottom to the top. This hole muſt be large enough to turn eaſy round the bottom of the ſpindle, at which place there muſt be a ſhoulder, to keep the wheel from touching the ſtand: at the top of the ſpindle put the ſmall wheel, and join it to a large one with a leader, in order that they may be fired both together.

93. *Caſcades of Fire,*

Plate cccclxxx.

Are made of any ſize; but one made according to the dimenſions of that ſhown in fig. 1. will be large enough for 8-oz. caſes. Let the diſtance from A to B be 3 feet; from B to C 2 feet 6 inches; and from CD 2 feet; and let the croſs piece at A be 4 feet long: then from each end of this piece draw a line to D; then make the other croſs pieces ſo long as to come within thoſe lines. The top piece D may be of any length, ſo as to hold the caſes, at a little diſtance from each other; all the croſs pieces are fixed horizontally, and ſupported by brackets; the bottom croſs piece ſhould be about 1 foot 6 inches broad in the middle, the ſecond 1 foot, the third 9 inches, and the top piece 4 inches: the caſes may be made of any length, but muſt be filled with a brilliant charge. On the edges of the croſs pieces muſt be nailed bits of wood, with a groove cut in each piece, large enough for a caſe to lie in. Theſe bits of wood are fixed ſo as to incline downwards, and that the fire from one tier of caſes may play over the other. All the caſes being tied faſt on, carry leaders from one to the other; and let there be a pipe hung from the mouth of one of the caſes, covered at the end with a ſingle paper, which you burn to fire the caſcade.

Of Wheels, &c.

94. *The Fire-Tree.*

To make a fire-tree, as ſhewn by fig. 2. you muſt firſt have a piece of wood 6 feet long, and 3 inches ſquare; then at E, 9 inches from the top, make a hole in the front, and in each ſide; or, inſtead of holes, you may fix ſhort pegs, to fit the inſide of the caſes. At F, 9 inches from E, fix 3 more pegs; at G, 1 foot 9 inches from F, fix 3 pegs; at H, 9 inches from G, fix 3 pegs; at I, 9 inches from H, fix 3 pegs, inclining downwards; but all the other pegs muſt incline upwards, that the caſes may have the ſame inclination as you ſee in the figure: then at top place a 4-inch mortar, loaded with ſtars, rains, or crackers. In the middle of this mortar place a caſe filled with any ſort of charge, but let it be fired with the other caſes: a brilliant charge will do for all the caſes; but the mortar may be made of any diameter, and the tree of any ſize; and on it any number of caſes, provided they are placed in the manner deſcribed.

95. *Chineſe Fountains.*

To make a Chineſe fountain, you muſt have a perpendicular piece of wood 7 feet long and $2\frac{1}{2}$ inches ſquare. Sixteen inches from the top, fix on the front a croſs-piece 1 inch thick, and $2\frac{1}{2}$ broad, with the broad ſide up: below this, fix 3 more pieces of the ſame width and thickneſs, at 16 inches from each other: let the bottom rail be 5 feet long, and the others of ſuch a length as to allow the fire-pumps to ſtand in the middle of the intervals of each other. The pyramid being thus made, fix in the holes made in the bottom rail 5 fire-pumps, at equal diſtances; on the 2d rail, place 4 pumps; on the 3d, 3; on the 4th, 2; and on the top of the poſt, 1; but place them all to incline a little forwards, that, when they throw out the ſtars, they may not ſtrike againſt the croſs rails. Having fixed your fire-pumps, clothe them with leaders, ſo that they may all be fired together. See fig. 3.

96. *Of illuminated Globes with horizontal Wheels.*

The hoops for theſe globes may be made of wood, tin, or iron wire, about 2 feet diameter. For a ſingle globe take two hoops, and tie them together, one within the other, at right angles; then have a horizontal wheel made, whoſe diameter muſt be a little wider than the globe, and its nave 6 inches long; on the top of which the globe is fixed, ſo as to ſtand 3 or 4 inches from the wheel: on this wheel you may put any number of caſes, filled with what charge you like; but let two of them burn at a time: they may be placed horizontally, or to incline downwards, juſt as you chooſe. Now, when the wheel is clothed, fix on the hoops as many illuminations as will ſtand within $2\frac{1}{2}$ inches of each other: theſe you faſten on the hoops with ſmall iron binding wire; and when they are all on, put on your pipes of communication, which muſt be ſo managed as to light them all with the 2d or 3d caſe on the wheel. The ſpindle on which the globe is to run muſt go through the block of the wheel, up to the inſide of the top of the globe; where muſt be fixed a bit of braſs, or iron, with a hole in it to receive the point of the ſpindle, on which the whole weight of the wheel is to bear, as in fig. 4. which repreſents a globe on its ſpindle. By this method may be made a

Of Wheels, &c.

crown, which is done by having the hoops bent in the form of a crown. Sometimes globes and crowns are ordered ſo as to ſtand ſtill, and the wheel only to turn round; but when you would have the globe or crown to ſtand ſtill, and the wheel to run by itſelf, the block of the wheel muſt not be ſo long, nor the ſpindle any longer than to juſt raiſe the globe a little above the wheel; and the wheel-caſes and illumination muſt begin together.

97. *Dodecaedron,*

So called becauſe it nearly repreſents a twelve-ſided figure, is made thus. Firſt have a ball turned out of ſome hard wood, 14 inches diameter: when done, divide its ſurface into 14 equal parts, from which bore holes $1\frac{1}{4}$ inch diameter, perpendicular to the centre, ſo that they may all meet in the middle: then let there be turned in the inſide of each hole a female ſcrew; and to all the holes but one, muſt be made a round ſpoke 5 feet long, with 4 inches of the ſcrew at one end to fit the holes; then in the ſcrew-end of all the ſpokes bore a hole, 5 inches up, which muſt be bored ſlanting, ſo as to come out at one ſide, a little above the ſcrew; from which cut a ſmall groove along the ſpoke, within 6 inches of the other end, where you make another hole through to the other ſide of the ſpoke. In this end fix a ſpindle, on which put a ſmall wheel of 3 or 4 ſides, each ſide 6 or 7 inches long: theſe ſides muſt have grooves cut in them, large enough to receive a 2 or 4 oz. caſe. When theſe wheels are clothed, put them on the ſpindles, and at the end of each ſpindle put a nut to keep the wheel from falling off. The wheels being thus fixed, carry a pipe from the mouth of the firſt caſe on each wheel, through the hole in the ſide of the ſpoke, and from thence along the groove, and through the other hole, ſo as to hang out at the ſcrew-end about an inch. The ſpokes being all prepared in this manner, you muſt have a poſt, on which you intend to fire the work, with an iron ſcrew in the top of it, to fit one of the holes in the ball: on the ſcrew fix the ball; then in the top hole of the ball put a little meal-powder, and ſome looſe quick-match: then ſcrew in all the ſpokes; and in one ſide of the ball bore a hole, in which put a leader, and ſecure it at the end; and your work will be ready to be fired. By this leader the powder and match in the centre is fired, which will light the match at the ends of the ſpokes all at once, whereby all the wheels will be lighted at once. There may be an addition to this piece, by fixing a ſmall globe on each wheel, or one on the top wheel only. A grey charge will be proper for the wheel-caſes.

98. *The New-Tree of brilliant Fire,*

Is repreſented by fig. 5. as it appears when burning. Firſt, let A be an upright piece of wood, 4 feet long, 2 inches broad, and 1 thick: at top of this piece, on the flat ſide, fix a hoop 14 inches diameter; and round its edge and front place illuminations, and in the centre a 5-pointed ſtar; then at E, which is $1\frac{1}{2}$ foot from the edge of the hoop, place 2 caſes of brilliant fire, one on each ſide: theſe caſes ſhould be 1 foot long each: below theſe fix 2 more caſes of the ſame ſize, and at ſuch a diſtance, that their mouths may almoſt meet them at top: then cloſe to the ends of theſe caſes fix 2 more of the ſame caſes; they muſt ſtand parallel to them at E. The caſes being thus fixed, clothe them with leaders; ſo that they, with the illuminations and ſtars at top, may all take fire together.

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99. *Stars with Points for regulated Pieces,* &c.

Theſe ſtars are made of different ſizes, according to the work for which they are intended: they are made with caſes from 1 oz. to 1 lb. but in general with 4 oz. caſes, 4 or 5 inches long: the caſes muſt be rolled with paſte, and twice as thick of paper as a rocket of the ſame bore. Having rolled a caſe, pinch one end of it quite cloſe: then drive in $\frac{1}{2}$ a diameter of clay; and when the caſe is dry, fill it with compoſition, 2 or 3 inches to the length of the caſes with which it is to burn: at top of the charge drive ſome clay; as the ends of theſe caſes are ſeldom pinched, they would be liable to take fire. Having filled a caſe, divide the circumference of it at the pinched end cloſe to the clay into 5 equal parts; then bore 5 holes with a gimblet, about the ſize of the neck of a common 4-oz. caſe, into the compoſition: from one hole to the other carry a quick-match, and ſecure it with paper: this paper muſt be put on in the manner of that on the ends of wheel-caſes, ſo that the hollow part, which projects from the end of the caſe, may ſerve to receive a leader from any other work, to give fire to the points of the ſtars. Theſe ſtars may be made with any number of points.

100. *Fixed Sun with a tranſparent Face.*

To make a ſun of the beſt ſort, there ſhould be two rows of caſes, as in fig. 6. which will ſhow a double glory, and make the rays ſtrong and full. The frame, or ſun-wheel, muſt be made thus: Have a circular flat nave made very ſtrong, 12 inches diameter: to this fix 6 ſtrong flat ſpokes, A,B,C,D,E,F. On the front of theſe fix a circular fell, 5 feet diameter; within which fix another fell, the length of one of the ſun-caſes leſs in diameter; within this fix a 3d fell, whoſe diameter muſt be leſs than the 2d by the length of 1 caſe and 1-3d. The wheel being made, divide the fells into ſo many equal parts as you would have caſes (which may be done from 24 to 44): at each diviſion fix a flat iron ſtaple; theſe ſtaples muſt be made to fit the caſes, to hold them faſt on the wheel; let the ſtaples be ſo placed, that one row of caſes may lie in the middle of the intervals of the other.

In the centre of the block of the ſun drive a ſpindle, on which put a ſmall hexagon wheel, whoſe caſes muſt be filled with the ſame charge as the caſes of the ſun: two caſes of this wheel muſt burn at a time, and begin with them on the fells. Having fixed on all the caſes, carry pipes of communication from one to the other, as you ſee in the figure, and from one ſide of the ſun to the wheel in the middle, and from thence to the other ſide of the ſun. Theſe leaders will hold the wheel ſteady while the ſun is fixing up, and will alſo be a ſure method of lighting both caſes of the wheel together. A ſun thus made is called a *brilliant ſun*, becauſe the wood work is entirely covered with fire from the wheel in the middle, ſo that there appears nothing but ſparks of brilliant fire: but if you would have a tranſparent face in the centre, you muſt have one made of paſteboard of any ſize. The method of making a face is, by cutting out the eyes, noſe, and mouth, for the ſparks of the wheel to appear through; but inſtead of this face, you may have one painted on oiled paper, or Perſian ſilk, ſtrained tight on a hoop; which

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which hoop muſt be ſupported by 3 or 4 pieces of wire at 6 inches diſtance from the wheel in the centre, ſo that the light of it may illuminate the face. By this method you may have, in the front of a ſun, VIVAT REX, cut in paſteboard, or Apollo painted on ſilk; but, for a ſmall collection, a ſun with a ſingle glory, and a wheel in front, will be moſt ſuitable. Half-pound caſes, filled 10 inches with compoſition, will be a good ſize for a ſun of 5 feet diameter; but, if larger, the caſes muſt be greater in proportion.

101. *Three Vertical Wheels illuminated, which turn on their own Naves upon a horizontal Table.*

A plan of this is ſhown by fig. 7. Let D be a deal table 3 feet in diameter: this table muſt be fixed horizontally on the top of a poſt; on this poſt muſt be a perpendicular iron ſpindle, which muſt come through the centre of the table: then let A,B,C, be 3 ſpokes joined to a triangular flat piece of wood, in the middle of which make a hole to fit eaſily over the ſpindle: let E,F,G, be pieces of wood, 4 or 5 inches long each, and 2 inches ſquare, fixed on the under ſides of the ſpokes; in theſe pieces make holes lengthwiſe to receive the thin part of the blocks of the wheels, which, when in, are prevented from coming out by a ſmall iron pin being run through the end of each. K, L, M, are 3 vertical octagon wheels, 18 inches diameter each: the blocks of theſe wheels muſt be long enough for 3 or 4 inches to reſt on the table; round which part drive a number of ſharp points of wire, which muſt not project out of the blocks more than 1-16th of an inch: the uſe of theſe points is, that, when the blocks run round, they will ſtick in the table, and help the wheels forward: if the naves are made of ſtrong wood, one inch will be enough for the diameter of the thin part, which ſhould be made to turn eaſy in the holes in the pieces E, F, G. On the front of the wheels make 4 or 5 circles of ſtrong wire, or flat hoops, and tie on them as many illuminations as they will hold at 2 inches from each other: inſtead of circles, you may make ſpiral lines, clothed with illuminations, at the ſame diſtance from each other as thoſe on the hoops. When illuminations are fixed on a ſpiral line in the front of a wheel, they muſt be placed a little on the ſlant, the contrary way that the wheel runs: the caſes for theſe wheels may be filled with any coloured charge, but muſt burn only one at a time.

The wheels being thus prepared, you muſt have a globe, crown, or ſpiral wheel, to put on the ſpindle in the middle of the table: this ſpindle ſhould be juſt long enough to raiſe the wheel of the globe, crown, or ſpiral wheel, ſo high that its fire may play over the 3 vertical wheels: by this means their fires will not be confuſed, nor will the wheels receive any damage from the fire of each other. In clothing this work, let the leaders be ſo managed, that all the wheels may light together, and the illuminations after 2 caſes of each wheel are burned.

102. *Illuminated Chandelier.*

Illuminated works are much admired by the Italians, and indeed are a great addition to a collection of works: in a grand exhibition an illuminated piece ſhould be fired after every two or three wheels, or fixed pieces of common and brilliant fires; and likewiſe illuminated works may be made cheap, quick, and eaſy.

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To make an illuminated chandelier, you muſt firſt have one made of thin wood (ſee fig. 8.) The chandelier being made, bore in the front of the branches, and in the body, and alſo in the crown at top, as many holes for illuminations as they will contain at 3 inches diſtance from each other: in theſe holes put illuminations filled with white, blue, or brilliant charge. Having fixed in the port-fires, clothe them with leaders, ſo that the chandelier and crown may light together. The ſmall circles on this figure repreſent the mouths of the illuminations, which muſt project ſtraight from the front.

103. *Illuminated Yew Tree.*

Firſt have a tree made of wood, ſuch as is ſhown by fig. 9. The middle piece or ſtem, on which the branches are fixed, muſt be 8 feet 6 inches high: at the bottom of this piece draw a line, at right angles, 2 feet 6 inches long at each ſide; then from L, which is 1 foot 6 inches from the bottom, draw a line on each ſide to C and D: theſe lines will give the length of the two firſt branches. Then put on the two top branches parallel to them at bottom: let the length of each of theſe branches be 1 foot from the ſtem: from the ends of theſe two branches draw a line to C and D: then fix on 5 more branches at an equal diſtance from each other, and their length will be determined by the lines AC and ED. When the branches are fixed, place illuminating portfires on the top of each, as many as you chooſe: behind the top of the ſtem faſten a gerbe or white fountain, which muſt be fired at the beginning of the illuminations on the tree.

104. *Flaming Stars with brilliant Wheels.*

To make a flaming ſtar, you muſt firſt have made a circular piece of ſtrong wood about 1 inch thick and 2 feet diameter: round this block fix 8 points, 2 feet 6 inches long each; 4 of theſe points muſt be ſtraight and 4 flaming: theſe points being joined on very ſtrong, and even with the ſurface of the block, nail tin or paſteboard on their edges, from the block to the end of each, where they muſt be joined: this tin muſt project in front 8 inches, and be joined where they meet at the block; round the front of the block fix 4 pieces of thick iron wire, 8 inches long each, equally diſtant from each other: this being done, cut a piece of paſteboard round, 2 feet diameter, and draw on it a ſtar, as may be ſeen in fig. 10. Cut out this ſtar, and on the back of it paſte oiled paper; then paint each point half red and half yellow, lengthwiſe; but the body of the ſtar muſt be left open, wherein muſt run a brilliant wheel, made thus: Have a light block turned 9 inches long: at each end of it fix 6 ſpokes; at the end of each ſpoke put a 2 ounce caſe of brilliant fire: the length of theſe caſes muſt be in proportion to the wheel, and the diameter of the wheel when the caſes are on muſt be a little leſs than the diameter of the body of the ſmall ſtar: the caſes on the ſpokes in front muſt have their mouths incline outwards, and thoſe on the inſide ſpokes muſt be placed ſo as to form a vertical circle of fire. When you place your leaders, carry the firſt pipe from the tail of 1 of the caſes in front to the mouth of 1 of the inſide caſes, and from the tail of that to another in front, and ſo on to all the caſes. Your wheel being made, put it on a ſpindle, in the centre of the ſtar; this ſpindle muſt have a ſhoulder at bottom, to keep the wheel at a little diſtance from the block. This wheel muſt be kept on the

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the ſpindle by a nut at the end; having fixed on the wheel, faſten the tranſparent ſtar to the 4 pieces of wire: when you fire it, you will only ſee a common horizontal wheel; but when the firſt caſe is burnt out, it will fire one of the vertical caſes, which will ſhow the tranſparent ſtar, and fill the large flames and points with fire; then it will again appear like a common wheel, and ſo on for 12 changes.

105. *Projected regulated Piece of nine Mutations.*

A regulated piece, if well executed, is as curious as any in fire-works: it conſiſts of fixed and moveable pieces on one ſpindle, repreſenting various figures, which take fire ſucceſſively one from another, without any aſſiſtance after lighting the firſt mutation. See fig. 11.

I. Names of the mutations, with the colour of fire and ſize of the caſe belonging to each.

Firſt mutation is a hexagon vertical wheel, illuminated in front with ſmall portfires tied on the ſpokes; this wheel muſt be clothed with 2 ounce caſes, filled with black charge; the length of theſe caſes is determined by the ſize of the wheel, but muſt burn ſingly.

Second mutation is a fixed piece, called a *golden glory*, by reaſon of the caſes being filled with ſpur-fire. The caſes muſt ſtand perpendicular to the block on which they are fixed, ſo that, when burning, they may repreſent a glory of fire. This mutation is generally compoſed of 5 or 7 two ounce caſes.

Third mutation is moveable; and is only an octagon vertical wheel, clothed with 4 ounce caſes, filled with brilliant charge: 2 of theſe caſes muſt burn at a time. In this wheel you may make changes of fire.

Fourth mutation, is a fixed ſun of brilliant fire, conſiſting of 12 four ounce caſes: the necks of theſe caſes muſt be a little larger than thoſe of 4 ounce wheel-caſes. In this mutation may be made a change of fire, by filling the caſes half with brilliant charge, and half with grey.

Fifth mutation, is a fixed piece, called the *porcupine's quills*. This piece conſiſts of 12 ſpokes, ſtanding perpendicular to the block in which they are fixed; on each of theſe ſpokes, near the end, muſt be placed a 4 ounce caſe of brilliant fire. All theſe caſes muſt incline either to the right or left, ſo that they may all play one way.

Sixth mutation, is a ſtanding piece, called the *croſs fire*. This mutation conſiſts of 8 ſpokes fixed in a block; near the end of each of thoſe ſpokes muſt be tied two 4 ounce caſes of white charge, one acroſs the other, ſo that the fires from the caſes on one ſpoke may interſect the fire from the caſes on the other.

Seventh mutation, is a fixed wheel, with 2 circular fells, on which are placed 16 eight-ounce caſes of brilliant fire, in the form of a ſtar. This piece is called a *fixed ſtar of wild-fire*.

Eighth mutation. This is a beautiful piece, called a *brilliant ſtar-piece*. It conſiſts of 6 ſpokes, which are ſtrengthened by 2 fells of a hexagon form, at ſome diſtance from each other: at the end of each ſpoke, in the front, is fixed a brilliant ſtar of 5 points; and on each ſide of every ſtar is placed a 4 ounce caſe of black or grey charge; theſe caſes muſt be placed with their mouths ſidewiſe, ſo that their fires may croſs each other.

Ninth mutation, is a wheel-piece. This is compoſed of 6 long ſpokes, with a hexagon vertical wheel at the end of each; theſe wheels run on ſpindles in the front of the ſpokes; all the wheels are lighted together: 2 ounce caſes will do for theſe wheels, and may be filled with any coloured charge.

Of Wheels, &c.

II. Proportions of the mutations, with the method of conveying the fire from one to the other, and the diſtance they ſtand one from the other on the ſpindle.

Firſt Mutation, muſt be a hexagon vertical wheel, 14 inches diameter; on one ſide of the block, whoſe diameter is $2\frac{1}{4}$ inches, is fixed a tin barrel A (ſee fig. 11. n° 1.) This barrel muſt be a little leſs in diameter than the nave; let the length of the barrel and block be 6 inches. Having fixed the caſes on the wheel, carry a leader from the tail of the laſt caſe into the tin barrel through a hole made on purpoſe, 2 inches from the block; at the end of this leader let there be about 1 inch or 2 of looſe match; but take care to ſecure well the hole wherein the pipe is put, to prevent any ſparks falling in, which would light the ſecond mutation before its time, and confuſe the whole.

Second mutation is thus made. Have a nave turned $2\frac{1}{2}$ inches diameter, and 3 long; then let $\frac{1}{2}$ an inch of that end which faces the firſt wheel be turned ſo as to fit eaſy into the tin barrel of the firſt mutation, which muſt turn round it without touching. On the other end of the block fix a tin barrel B, n° 2. This barrel muſt be 6 inches long, and only half an inch of it to fit on the block. Round the nave fix 5 ſpokes, $1\frac{1}{2}$ inch long each; the diameter of the ſpokes muſt be equal to a 2 oz. former. On theſe ſpokes put five 7-inch 2-oz. caſes of ſpur-fire, and carry leaders from the mouth of one to the other, that they may all light together. Then from the mouth of one of the caſes carry a leader through a hole bored ſlantwiſe in the nave, from between the ſpokes, to the front of the block near the ſpindle hole: the end of this leader muſt project out of the hole into the barrel of the firſt mutation, ſo that when the pipe which comes from the end of the laſt caſe on the firſt wheel flaſhes, it may take fire, and light the 2d mutation. To communicate the fire to the 3d mutation, bore a hole near the bottom of one of the 5 caſes to the compoſition, and from thence carry a leader into a hole made in the middle of the barrel B: this hole muſt be covered with paſted paper.

Third mutation, may be either an octagon or hexagon wheel, 20 inches diameter; let the nave be $3\frac{1}{2}$ inches diameter, and $3\frac{1}{2}$ in length; $1\frac{1}{2}$ inch of the front of the nave muſt be made to fit in the barrel B. On the other end of the block fix a tin barrel C, n° 3. This barrel muſt be $6\frac{1}{2}$ inches in length, one inch of which muſt fit over the block. The caſes of this wheel muſt burn 2 at a time; and from the mouths of the 2 firſt caſes carry a leader, through holes in the nave, into the barrel of the ſecond mutation, after the uſual manner: but beſides theſe leaders let a pipe go acroſs the wheel from one firſt caſe to the other; then from the tail of one of the laſt caſes carry a pipe into a hole in the middle of the barrel C: at the end of this pipe let there be ſome looſe quick-match.

Fourth and fifth mutations. Theſe may be deſcribed under

Of Wheels, &c.

under one head, as their naves are made of one piece, which from E to F is 14 inches; E, a block 4 inches diameter, with 10 or 12 ſhort ſpokes, on which are fixed 11-inch 8-oz. caſes: let the front of this block be made to fit eaſy in the barrel C, and clothe the caſes ſo that they may all light together; and let a pipe be carried through a hole in the block into the barrel C, in order to receive the fire from the leader brought from the laſt caſe on the wheel. G is the nave of the 5th mutation, whoſe diameter muſt be 4½ inches: in this nave fix 10 or 12 ſpokes, 1½ foot in length each; theſe ſpokes muſt ſtand 7 inches diſtant from the ſpokes of the 4th mutation; and at the end of each ſpoke tie a 4-oz. caſe, as n° 5. All theſe caſes are to be lighted together, by a leader brought from the end of one of the caſes on n° 4. Let F and H be of the ſame piece of wood as E and G, but as much thinner as poſſible, to make the work light.

Sixth and ſeventh mutations. The blocks of theſe 2 mutations are turned out of one piece of wood, whoſe length from F to P is 15 inches. L, a block 5 inches diameter, in which are fixed 8 ſpokes, each 2 feet 4 inches long; at the end of each ſpoke tie two 4-oz. caſes, as n° 6. All theſe caſes muſt be fired at the ſame time, by a pipe brought from the end of one of the caſes on the 5th mutation. Let the diſtance between the ſpokes at L, and thoſe in the 5th mutation, be 7 inches. M, the nave of the 7th mutation, whoſe diameter muſt be 5½ inches: in this nave fix 8 ſpokes, and on the front of them 2 circular fells, one of 4 feet 8 inches diameter, and one of 3 feet 11 diameter; on theſe fells tie 16 8-oz. or pound caſes, as in n° 7. and carry leaders from one to the other, ſo that they may be all fired together. This mutation muſt be fired by a leader brought from the tail of one of the caſes on the 6th mutation.

Eighth and ninth mutations. The blocks of theſe may be turned out of one piece, whoſe length from P to D muſt be 12 inches. O, the block of the 8th mutation, which muſt be 6 inches diameter; and in it muſt be fixed 6 ſpokes, each 3 feet in length, ſtrengthened by an hexagon fell within 3 or 4 inches of the ends of the ſpokes: cloſe to the end of each ſpoke, in the front, fix a five-pointed brilliant ſtar; then 7 inches below each ſtar tie two 10-inch 8 oz. caſes, ſo that the upper ends of the caſes may reſt on the fells, and their ends on the ſpokes. Each of theſe caſes muſt be placed parallel to the oppoſite fell (ſee n° 8.) NNN, &c. are the caſes, and kkk, &c. the ſtars.

The 9th mutation is thus made. Let D be a block 7 inches diameter. In this block muſt be ſcrewed 6 ſpokes, 6 feet long each, with holes and grooves for leaders, as thoſe in the dodecaedron; at the end of each ſpoke, in the front, fix a ſpindle for a hexagon vertical wheel, 10 inches diameter, as in n° 9. When theſe wheels are on, carry a leader from each into the block, ſo that they may all meet; then lead a pipe from the end of one of the caſes of the 8th mutation, through a hole bored in the block D, to meet the leaders from the vertical wheels, ſo that they may all be fired together.

The ſpindles for larger pieces are required to be made very ſtrong, and as exact as poſſible: for a piece of 9 mutations, let the ſpindle be at the large end 1 inch diameter, and continue that thickneſs as far as the 7th mutation; and thence to the 5th, let its diameter be ¾ of an inch; from the 5th to the 4th, 5-8ths of an inch; from the 4th to the 2d, ½ inch; and from the 2d to the end, 3-8ths of an inch. At the ſmall end muſt be a nut to keep on the firſt wheel, and at the thick end muſt be a large nut, as ſhown by the figure; ſo that the ſcrew part of the ſpindle being put through a poſt, and a nut ſcrewed on tight, the ſpindle will be held faſt and ſteady: but you are to obſerve, that that part of the ſpindle on which the moveable pieces are to run, be made long enough for the wheels to run eaſy without ſticking; the fixed pieces being made on different blocks, the leaders muſt be joined, after they are fixed on the ſpindle. The beſt method of preventing the fixed mutations from moving on the ſpindle, is to make that part of the ſpindle which goes through them ſquare; but as it would be difficult to make ſquare holes through ſuch long blocks as are ſometimes required, it will be beſt to make them thus: Bore a hole a little larger than the diameter of the ſpindle; and at each end of the block, over the hole, faſten a piece of braſs with a ſquare hole in it to fit the ſpindle.

Of Wheel, &c.

106. *To make an Horizontal Wheel change to a Vertical Wheel with a Sun in front.*

The ſudden change of this piece is very pleaſing; and gives great ſurpriſe to thoſe who are not acquainted with the contrivance. A wheel for this purpoſe ſhould be about three feet diameter, and its fell circular; on which tie 16 half-pound caſes filled with brilliant charge: two of theſe caſes muſt burn at a time; and on each end of the nave muſt be a tin barrel of the ſame conſtruction as thoſe on the regulated piece. The wheel being completed, prepare the poſt or ſtand thus: Firſt have a ſtand made of any height, about three or four inches ſquare; then ſaw off from the top a piece two feet long; this piece join again at the place where it was cut, with a hinge on one ſide, ſo that it may lift up and down in the front of the ſtand; then fix on the top of the bottom-part of the ſtand, on each ſide, a bracket; which brackets muſt project at right angles with the ſtand, one foot from the front, for the ſhort piece to reſt on. Theſe brackets muſt be placed a little above the joint of the poſt, ſo that when the upper ſtand falls, it may lie between them at right angles with thē bottom ſtand; which may be done by fixing a piece of wood, one foot long, between the brackets, and even with the top of the bottom ſtand; then, as the brackets riſe above the bottom ſtand, they will form a channel for the ſhort poſt to lie in, and keep it ſteady without ſtraining the hinge. On the ſide of the ſhort poſt, oppoſite the hinge, nail a piece of wood, of ſuch a length, that, when the poſt is perpendicular, it may reach about 1½ feet down the long poſt; to which being tied, it will hold the ſhort ſtand upright. The ſtand being thus prepared, in the top of it fix a ſpindle 10 inches long: on this ſpindle put the wheel: then fix on a brilliant ſun with a ſingle glory; the diameter of this ſun muſt be 6 inches leſs than that of the wheel. When you fire this piece, light the wheel firſt, and let it run horizontally till four caſes are conſumed: then from the end of the fourth caſe carry a leader into the tin barrel that turns over the end of the ſtand: this leader muſt be met by another brought through the top of the poſt, from a caſe filled with a ſtrong

Of Wheels, &c.

port-fire charge, and tied to the bottom poſt, with its mouth facing the packthread which holds up the ſtand; ſo that when this caſe is lighted, it will burn the packthread, and let the wheel fall forward, by which means it will become vertical: then from the laſt caſe of the wheel, carry a leader into the barrel next the ſun, which will begin as ſoon as the wheel is burnt out.

107. *Grand Volute illuminated with a projected Wheel in front.*

Plate CCCCXXXI.

Firſt have two hoops made of ſtrong iron wire, one of 6 feet diameter, and one of 4 feet 2 inches; theſe hoops muſt be joined to ſcrolls A, A, A, &c. as in fig. 1. Theſe ſcrolls muſt be made of the ſame ſort of wire as the hoops; on theſe ſcrolls tie, with iron-binding wire, as many illuminating port-fires as they will hold, at two inches diſtance; clothe theſe port-fires with leaders, ſo that they may all take fire together.—Then let C be a circular wheel of four ſpokes, 3 feet 6 inches diameter; and on its fell tie as many 4-oz. caſes, head to tail, as will complete the circle, only allowing a ſufficient diſtance between the caſes, that the fire may paſs free; which may be done by cutting the upper part of the end of each caſe a little ſhelving: on each ſpoke fix a 4-oz. caſe, about three inches from the fell of the wheel: theſe caſes are to burn one at a time, and the firſt of them to begin with thoſe on the fell, of which four are to burn at a time; ſo that the wheel will laſt no longer than $\frac{1}{4}$ of the caſes on the fell, which in number ſhould be 16 or 20. On the front of the wheel form a ſpiral line with ſtrong wire, on which tie port-fires, placing them on a ſlant, with their mouths to face the ſame way as the caſes on the wheel: all theſe port-fires muſt be fired with the ſecond caſes of wheel. Let D, D, D, &c. be ſpokes of wood, all made to ſcrew into a block in the centre; each of theſe ſpokes may be in length about 4 feet 6 inches; in the top of each fix a ſpindle, and on each ſpindle put a ſpiral wheel of 8 ſpokes, ſuch as E, E, E, &c. The blocks of theſe wheels muſt have a hole at top for the centre caſes, and the ſpindle muſt have nuts ſcrewed on their ends; which nuts ſhould fit in the holes at top of the blocks, ſo that all the wheels muſt be put on before you fix in the centre caſes: as ſome of theſe wheels, by reaſon of their ſituation, will not bear on the nut, it will be neceſſary to have ſmooth ſhoulders made on the ſpindles for the blocks to run on. The caſes of theſe wheels are to burn double; and the method of firing them, is by carrying a leader from each down the ſpokes into the block in the centre, as in the dodecaedron, but the centre caſe of each wheel muſt begin with the two laſt caſes as uſual. It is to be obſerved, that the large circular wheel in front muſt have a tin barrel on its block, into which a pipe muſt be carried from one of the ſecond caſes on the wheel; this pipe being met by another from the large block, in which the 8 ſpokes are ſcrewed, will fire all the ſpiral wheels and the illuminating port-fires at the ſame time. The caſes of the projected wheel may be filled with a white charge, and thoſe of the ſpiral wheels with a grey.

108. *Moon and Seven Stars.*

Let fig. 2. be a ſmooth circular board 6 feet diameter: out of the middle of it cut a circular piece 12 or 14 inches diameter; and over the vacancy put white Perſian ſilk, on which paint a moon's face: then let I, I, I, &c. be ſtars, each 4 or 5 inches diameter, cut out with five points, and covered with oiled ſilk: on the front of the large circular board draw a 7-pointed ſtar, as large as the circle will allow; then on the lines which form this ſtar, bore holes, wherein fix pointed ſtars. When this caſe is to be fired, it muſt be fixed upon the front of a poſt, on a ſpindle, with a wheel of brilliant fire behind the face of the moon: ſo that, while the wheel burns, the moon and ſtars will appear tranſparent: and when the wheel has burnt out, they will diſappear, and the large ſtar in front, which is formed of pointed ſtars, will begin, being lighted by a pipe of communication from the laſt caſe of the vertical wheel, behind the moon; this pipe muſt be managed in the ſame manner as thoſe in regulated pieces.

Of Wheels, &c.

109. *Double Cone-Wheel illuminated.*

This piece is repreſented by fig. 3. Let A be a ſtrong decagon wheel, 2 feet 6 inches diameter; then on each ſide of it fix a cone B and C: theſe cones are to conſiſt of a number of hoops, ſupported by 3 or 4 pieces of wood, in the manner of the ſpiral wheels. Let the height of each cone be 3 feet 6 inches; and on all the hoops tie port-fires horizontally, with their mouths outwards, and clothe the wheel with 8-oz. caſes, all to play horizontally, two at a time: the cones may be fired with the firſt or ſecond caſes. The ſpindle for this piece muſt go through both the cones, and riſe three feet above the point of the cone at top; ſo that its length will be 10 feet 4 inches from the top of the poſt H, in which it is fixed, allowing four inches for the thickneſs of the block of the wheel. The whole weight of the wheel and cones muſt bear on a ſhoulder in the ſpindle, on which the block of the wheel muſt turn.—Near the top of the ſpindle muſt be a hole in the front, into which ſcrew a ſmall ſpindle, after the cones are on: then on this ſmall ſpindle fix a ſun D, compoſed of ſixteen 9-inch 4-oz. caſes of brilliant fire; which caſes muſt not be placed on a fell, but only ſtuck into a block of 6 inches diameter: then in the front of this ſun muſt be a circular vertical wheel, 16 inches diameter; on the front of this wheel form with iron-wire a ſpiral line, and clothe it with illuminations after the uſual method. As this wheel is not to be fired till the cones are burnt out, the method of firing it is thus: Let the hole in the block, at the top of the uppermoſt cone, be a little larger than the ſpindle which paſſes through it. Then, from the firſt caſe of the vertical wheel before the ſun, carry a leader down the ſide of the ſpindle to the top of the block of the horizontal wheel, on which muſt be a tin barrel: then this leader being met by another brought from the end of the laſt caſe of the horizontal wheel, will give fire to the vertical wheel ſo ſoon as the cones are extinguiſhed: but the ſun D muſt not be fired till the vertical wheel is quite burnt out.

110. *Fire-pumps.*

Caſes for fire-pumps are made as thoſe for tourbillons; only they are paſted, inſtead of being rolled dry. Having rolled and dried your caſes, fill them: firſt put in a little meal-powder, and then a ſtar; on which ram lightly a ladle or two of compoſition, then a little meal-powder, and on that a ſtar, then again compoſition; and ſo on till you have filled the caſe. Stars for fire-pumps ſhould not be round; but muſt be made either ſquare, or flat and circular, with a hole through the middle:

Wheels, &c. middle: the quantity of powder for throwing the ſtars muſt increaſe as you come near the top of the caſe; for, if much powder be put at the bottom, it will burſt the caſe. The ſtars muſt differ in ſize in this manner: Let the ſtar which you put in firſt be about $\frac{1}{4}$ leſs than the bore of the caſe; but let the next ſtar be a little larger, and the third ſtar a little larger than the ſecond, and ſo on: let them increaſe in diameter till within two of the top of the caſe, which two muſt fit in tight. As the loading of fire-pumps is ſomewhat difficult, it will be neceſſary to make two or three trials before you depend on their performance: when you fill a number of pumps, take care not to put in each an equal quantity of charge between the ſtars, ſo that when they are fired, they may not throw up too many ſtars together. Caſes for fire-pumps ſhould be made very ſtrong, and rolled on 4 or 8 oz. formers, 10 or 12 inches long each.

111. *Vertical Scroll Wheel.*

Plate CCCCXXXI. This wheel may be made of any diameter, but muſt be conſtructed as in fig. 4. to do which proceed thus: Have a block made of a moderate ſize, in which fix four flat ſpokes, and on them fix a flat circular fell of wood; round the front of this fell place port-fires; then on the front of the ſpokes form a ſcroll, either with a hoop or ſtrong iron wire; on this ſcroll tie caſes of brilliant fire, in proportion to the wheel, head to tail, as in the figure. When you fire this wheel, light the firſt caſe near the fell; then, as the caſes fire ſucceſſively, you will ſee the circle of fire gradually diminiſh: but whether the illuminations on the fell begin with the ſcroll or not, is immaterial, that being left entirely to the maker.

N. B. This wheel may be put in the front of a regulated piece, or fired by itſelf, occaſionally.

112. *Pin-Wheels.*

Firſt roll ſome paper pipes, about 14 inches long each; theſe pipes muſt not be made thick of paper, two or three rounds of elephant paper being ſufficient. When your pipes are thoroughly dried, you muſt have a tin tube 12 inches long, to fit eaſy into the pipes; at one end of this tube fix a ſmall conical cup, which cone is called a *funnel;* then bend one end of one of the pipes, and put the funnel in at the other as far as it will reach, and fill the cup with compoſition: then draw out the funnel by a little at a time, ſhaking it up and down, and it will fill the pipe as it comes out. Having filled ſome pipes, have ſome ſmall blocks made about one inch diameter and half an inch thick: round one of theſe blocks wind and paſte a pipe, and to the end of this pipe join another; which muſt be done by twiſting the end of one pipe to a point, and putting it into the end of the other with a little paſte: in this manner join four or five pipes, winding them one upon the other ſo as to form a ſpiral line. Having wound on your pipes, paſte two ſlips of paper acroſs them to hold them together: beſides theſe ſlips of paper, the pipes muſt be paſted together.

There is another method of making theſe wheels, viz. by winding on the pipes without paſte, and ſticking them together with ſealing-wax at every half turn; ſo that when they are fired, the end will fall looſe every time the fire paſſes the wax, by which means the circle of fire will be conſiderably increaſed. The formers for theſe pipes are made from $1\frac{5}{8}$ to 4-16ths of an inch diameter; and the compoſition for them is as follows: Meal-powder 8 oz. ſaltpetre 2 oz. and ſulphur 1: among theſe ingredients may be mixed a little ſteel-filings or the duſt of caſt iron: this compoſition ſhould be very dry, and not made too fine, or it will ſtick in the funnel. Theſe wheels may be fired on a large pin, and held in the hand with ſafety.

Different Pieces of Fire-works.

113. *Fire-globes.*

There are two ſorts of fire-globes; one with projected caſes; the other with the caſes concealed, thus: Have a globe made of wood, of any diameter you chooſe, and divide the ſurface of it into 14 equal parts, and at each diviſion bore a hole perpendicular to the centre: theſe holes muſt be in proportion to the caſes intended to be uſed: in every hole except one, put a caſe filled with brilliant, or any other charge, and let the mouths of the caſes be even with the ſurface of the globe; then cut in the globe a groove, from the mouth of one caſe to the other, for leaders, which muſt be carried from caſe to caſe, ſo that they may all be fired together; this done, cover the globe with a ſingle paper, and paint it. Theſe globes may be uſed to ornament a building.

Fire-globes with projected caſes are made thus: Your globe being made with 14 holes bored in it as uſual, fix in every hole except one, a caſe, and let each caſe project from the globe two-thirds of its length; then clothe all the caſes with leaders, ſo that they may all take fire at the ſame time. Fire-globes are ſupported by a pintle, made to fit the hole in which there is no caſe.

114. *To thread and join Leaders, and place them on different Works.*

Joining and placing leaders is a very eſſential part of fire-works, as it is on the leaders that the performance of all complex works depends; for which reaſon the method of conducting pipes of communication ſhall be here explained in as plain a manner as poſſible. Your works being ready to be clothed, proceed thus: Cut your pipes of a ſufficient length to reach from one caſe to the other; then put in the quick-match, which muſt always be made to go in very eaſy: when the match is in, cut it off within about an inch of the end of the pipe, and let it project as much at the other end; then faſten the pipe to the mouth of each caſe with a pin, and put the looſe ends of the match into the mouths of the caſes, with a little meal-powder: this done to all the caſes, paſte over the mouth of each two or three bits of paper. The preceding method is uſed for large caſes, and the following for ſmall, and for illuminations: Firſt thread a long pipe; then lay it on the tops of the caſes, and cut a bit of the under ſide, over the mouth of each caſe, ſo that the match may appear: then pin the pipe to every other caſe; but before you put on the pipes, put a little meal-powder in the mouth of each caſe. If the caſes thus clothed are port-fires on illuminated works, cover the mouth of each caſe with a ſingle paper; but if they are choaked caſes, ſituated ſo that a number of ſparks from other works may fall on them before they are fired, ſecure them with three or four papers, which muſt be paſted on very ſmooth, that there may be no creaſes for the ſparks to lodge in, which often ſet fire to the works before their time. Avoid as much as poſſible placing the leaders too near, or one acroſs the other ſo as to touch, as it may happen that the fleſh of one will

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will fire the other; therefore if your works ſhould be ſo formed that the leaders muſt croſs or touch, be ſure to make them very ſtrong, and ſecure at the joints, and at every opening.

When a great length of pipe is required, it muſt be made by joining ſeveral pipes in this manner: Having put on one length of match as many pipes as it will hold, paſte paper over every joint; but, if a ſtill greater length is required, more pipes muſt be joined, by cutting about an inch off one ſide of each pipe near the end, and laying the quick-match together, and tying them faſt with ſmall twine; after which, cover the joining with paſted paper.

115. *Placing Fire-works to be exhibited.*

Nothing adds more to the appearance of fire-works than the placing them properly; though the manner of placing them chiefly depends on the judgment of the maker. The following are the rules generally obſerved, whether the works are to be fired on a building or on ſtands: If they are a double ſet, place one wheel of a ſort on each ſide of the building; and next to each of them, towards the centre, place a fixed piece, then wheels, and ſo on; leaving a ſufficient diſtance between them for the fire to play from one without burning the other. Having fixed ſome of your works thus in front, place the reſt behind them, in the centre of their intervals: The largeſt piece, which is generally a regulated or tranſparent piece, muſt be placed in the centre of the building, and behind it a ſun, which muſt always ſtand above all the other works: A little before the building, or ſtands, place your large gerbes; and at the back of the works fix your marron batteries, *pots des aigrettes*, *pots des brins*, *pots des ſauciſſons*, air-balloons, and flights of rockets: The rocket ſtands may be fixed behind, or anywhere elſe, ſo as not to be in the way of the works.

Single collections are fired on ſtands; which ſtands are made in the ſame manner as theodolite ſtands, only the top part muſt be long or ſhort occaſionally: theſe ſtands may be fixed up very ſoon without much trouble.

116. *Order of Firing.*

1. Two ſignal
2. Six ſky
3. Two honorary
4. Four caduceus

(1–4: rockets)

5. Two vertical
6. Two ſpiral
7. Two tranſparent ſtars

(5–7: wheels illuminated)

8. A line rocket of five changes
9. Four tourbillons
10. Two horizontal wheels
11. Two air balloons illuminated
12. Two Chineſe fountains
13. Two regulating pieces of four mutations each
14. Two pots des aigrettes
15. Three large gerbes
16. A flight of rockets
17. Two balloon wheels
18. Two caſcades of brilliant fire
19. Twelve ſky-rockets
20. Two illuminated yew trees
21. Two air-balloons of ſerpents, and 2 compound
22. Four tourbillons
23. Two Fruiloni wheels
24. Two illuminated globes with horizontal wheels
25. One pot des ſauciſſons
26. Two plural wheels
27. Marron battery
28. Two chandeliers illuminated
29. Range of pots des brins
30. Twelve ſky-rockets
31. Two yew-trees of fire
32. Neſt of ſerpents
33. Two double cones illuminated
34. Regulating piece of ſeven mutations, viz.
    1. Vertical wheel illuminated
    2. Golden glory
    3. Octagon vertical wheel
    4. Porcupine's quills
    5. Croſs fires
    6. Star-piece with brilliant rays
    7. Six vertical wheels
35. Brilliant ſun
36. Large flight of rockets.

(23–24: Two; 25–36: Different Pieces of Fire-works.)

When water-works are to be exhibited, divide them into ſeveral ſets, and fire one ſet after every fifth or ſixth change of land and air-works. Obſerve this rule in firing a double ſet of works: Always begin with ſky-rockets, then two moveable pieces, then two fixed pieces, and ſo on; ending with a large flight of rockets, or a marron battery: if a ſingle collection, fire a fixed piece after every wheel or two, and now and then ſome air and water-works.

117. *Fountain of Sky-rockets.*

Fig. 5. repreſents a fountain of 30 rockets. Let A be a perpendicular poſt, 16 feet high from the ground, and 4 inches ſquare. Let the rail, or croſs piece C, be 1 foot 6 inches long, 3 inches broad, and 1 thick. The rail D, at bottom, muſt be 6 feet long, 1 foot broad, and 1 inch thick. F and G are the two ſides which ſerve to ſupply the rails D, E, H, I, C: theſe ſides are 1 foot broad at bottom, and cut in the front with a regular ſlope, to 3 inches at top; but their back edges muſt be parallel with the front of the pots A. The breadth of the rails E, H, I, will be determined by the breadth of the ſides: all the rails muſt be fixed at 2 feet diſtance from each other, and at right angles with the pots. Having placed the rails thus, bore in the bottom rail 10 holes, at equal diſtances, large enough to receive the ſtick of a one-pound rocket: in the back edge of this rail cut a groove from one end to the other, fit to contain a quick-match; then cut a groove in the top of the rail, from the edge of each hole, into the groove in the back: in the ſame manner cut in the ſecond rail, E, 8 holes and grooves; in the third rail, H, 6 holes and grooves; in the fourth rail, I, 4 holes and grooves; and in the top rail, 2 holes and grooves. B, a rail with holes in it to guide the ends of the rocket-ſticks: this rail muſt be fixed 6 feet from the rail D. The fountain frame being thus made, prepare your rockets thus: Tie round the mouth of each a piece of thin paper, large enough to go twice round, and to project about 1½ inch from the mouth of the rocket, which muſt be rubbed with wet meal-powder; in the mouth of each rocket put a leader, which ſecure well with the paper that projects from the mouth of the caſe: theſe leaders muſt be carried into the grooves

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in the back of the rails, in which lay a quick-match from one end to the other, and cover it with pasted paper: holes must be made in the rail D, to receive the ends of the sticks of the rockets in the rail E, and so on to the fourth rail; so that the sticks of the rockets at top will go through all the rails. The rockets being so prepared, fix a gerbe, or white flower-pot, on each rail, before the post, with their mouths inclining a little forwards: these gerbes must be lighted all at once. Behind or before each gerbe, fix a case of brilliant or slow fire: these cases must be filled so that they may burn out one after the other, to regulate the fountain; which may be done by carrying a leader from the end of each slow or brilliant fire, into the groove in the back of each rail. Different fixed rockets may be used in these fountains: but it will be best to fill the heads of the rockets on each rail with different sorts of things, in this manner; those at top with crackers, the next with rains, the third with serpents, the fourth with tailed stars, and the last flight with common or brilliant stars.

118. *Palm Tree.*

This piece, though made of common fires, and of a simple construction, has a very pleasing effect; owing to the fires intersecting so often, that they resemble the branches of trees. Let A (fig. 6.) be a perpendicular post, of any thickness, so that it is sufficiently strong to hold the cases; let the distance from B to C be 2 feet 6 inches, and C to D 2 feet 6 inches, and let the length of each cross piece be 2 feet; on each end of each fix a five-pointed star: then fix, on pegs made on purpose, 12-inch half-pound cases of brilliant fire, as in the figure. All the cases and stars must be fired at once. This piece should be fixed high from the ground.

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119. *Illuminated Pyramid, with Archimedian Screws, a Globe, and vertical Sun,*

May be of any size. One made according to the dimensions of fig. 7. will be a good proportion, whose height is 21 feet; from C to D, 6 feet; from E to F, 9 feet: the space between the rails must be 6 inches, and the rails as thin as possible: in all the rails stick port-fires at four inches distance. The Archimedian screws, G, K, are nothing more than double spiral wheels, with the cases placed on their wheels horizontally instead of obliquely. The vertical sun, I, need not consist of more than 12 rays, to form a single glory. The globe at top must be made in proportion to the pyramid; which being prepared according to the preceding directions, place your leaders so that all the illuminating port-fires, screws, globe, and sun, may take fire together. The pyramid must be supported by the two sides, and by a support brought from a pole, which must be placed two feet from the back of the pyramid, that the wheels may run free.

120. *Rose-piece and Sun.*

A rose-piece may be used for a mutation of a regulated piece, or fired by itself: it makes the best appearance when made large; if its exterior diameter be 6 feet, it will be a good size. Fig. 8. shows the manner it appears in before it is fired. Let the exterior fell be made of wood, and supported by 4 wooden spokes: all the other parts, on which the illuminations are fixed, must be made of strong iron wire: on the exterior fell place as many half-pound cases of brilliant charge as you think proper, but the more the better; for the nearer the cases are placed, the stronger will be the rays of the sun: the illuminations should be placed within 3 inches of each other: they must all be fired together, and burn some time before the sun is lighted; which may be done by carrying a leader from the middle of one of the illuminations, to the mouth of one of the sun cases.

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121. *Transparent Stars with illuminated Rays.*

Fig. 9. represents an illuminated star. Let the diameter from A to B be 2 feet, and from C to D 7 feet. First make a strong circular back or body of the star, 2 feet diameter, to which you fix the illuminated rays: in the centre of the front of the body fix a spindle, on which put a double triangular wheel, 6 inches diameter, clothed with 2-ounce cases of brilliant charge: the cases on this wheel must burn but one at a time. Round the edge of the body nail a hoop made of thin wood or tin: this hoop must project in front 6 or 7 inches: in this hoop cut 3 or 4 holes to let out the smoke from the wheel. The star and garter may be cut out of strong pasteboard or tin, made in this manner: Cut a round piece of pasteboard or tin, 2 feet diameter, on which draw a star, and cut it out; then over the vacancy paste Persian silk; paint the letters yellow; 4 of the rays yellow, and 4 red; the cross in the middle may be painted half red and half yellow, or yellow and blue. This transparent star must be fastened to the wooden hoop by a screw, to take off and on; the illuminated rays are made of thin wood, with tin sockets fixed on their sides within 4 inches of each other; in these sockets stick illuminating port-fires; behind the point of each ray fix a half-pound case of grey, black, or Chinese fire.

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N. B. The illuminated rays to be lighted at the same time as the triangular wheel, or after it is burnt out; which may be done by a tin barrel being fixed to the wheel, after the manner of those in the regulated pieces. Into this barrel carry a leader from the illuminated rays, through the back of the star; which leader must be met by another, brought from the tail of the last case on the wheel.

122. *Transparent Table Star illuminated.*

Fig. 1. represents a table star, whose diameter, from E to F, is 12 feet; and from E to I, 4 feet. This proportion, observed on each side, will make the centre frame 4 feet square: in this square fix a transparent star, as in the figure. This star may be painted blue, and its rays made as those of the flaming stars described before. The wheel for this star may be composed of different coloured fires, with a charge or two of slow fire; the wheels *a*, *a*, *a*, *a*, may be clothed with any number of cases, so that the star-wheel consist of the same: the illuminating port-fires, which must be placed very near each other on the frames, must be so managed as to burn as long as the wheels, and lighted at the same time.

123. *The regulated illuminated Spiral Piece, with a projected Star-wheel illuminated.*

This piece is represented by fig. 2. and is thus made. Have a block made 8 inches diameter; in this block screw 6 iron spokes, which must serve for spindles for the spiral wheels: these wheels are made as usual, each $1\frac{1}{2}$ foot diameter, and 3 feet in height: the spindles must be long enough to keep the wheels 4 or 5 inches from one another: at the end of each spindle must be a

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ſcrew-nut, on which the wheels that hang downwards will run; and on the ſpindles which ſtand upwards muſt be a ſhoulder, for the blocks of the wheels to run on.

The projected ſtar-wheel muſt turn on the ſame ſpindle on which the large block is fixed; this ſpindle muſt be long enough to allow the ſtar-wheel to project a little before the ſpiral wheels: the exterior diameter of the ſtar-wheel muſt be 3 feet 5. On this wheel fix 3 circles of iron wire, and on them port-fires; on the block place a tranſparent ſtar, or a large 5-pointed brilliant ſtar. The caſes on this wheel may burn 4 at once, as it will contain near twice the number of one of the ſpiral wheels: the caſes on the ſpiral wheels muſt be placed parallel to their fells, and burn two at a time.

125. *A Figure-piece illuminated with five-pointed Stars.*

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The conſtruction of this piece is very eaſy, as ſhown by fig. 3. whoſe diameter from B to C is 8 feet, and from D to F 2 feet: the vertical wheel in the centre muſt be 1 foot diameter, and conſiſt of 6 four-ounce caſes of different coloured charge, which caſes muſt burn double: on the frames fix 5 pointed brilliant or blue ſtars, rammed 4 inches with compoſition: let the ſpace between each ſtar be 8 inches; at each point fix a gerbe, or caſe of Chineſe fire. When to be fired, let the gerbe, ſtars, and wheel, be lighted at the ſame time.

125. *The Star-wheel illuminated.*

This beautiful piece is ſhown by fig. 4. Its exterior fell is made of wood, 3 feet 6, or 4 feet diameter; within this fell, form with iron wire 3 circles, one leſs than the other, ſo that the diameter of the leaſt may be about 10 inches: place the port-fires on theſe fells with their mouths inclining outwards, and the port-fires on the points of the ſtar with their mouths projecting in front: let the exterior fell be clothed with 4 ounce caſes of grey charge: theſe caſes muſt burn 4 at a time, and be lighted at the ſame time as the illuminations.

126. *Pyramid of Flower-pots.*

Fig. 5, repreſents this curious piece, which muſt be made thus. Let the diſtance from A to B be 6 feet; and from one rail to the other, 2: on the bottom rail fix 5 paper mortars, each $3\frac{1}{2}$ inches diameter; theſe mortars load with ſerpents, crackers, ſtars, &c.

In the centre of each mortar fix a caſe of ſpur-fire: on the ſecond rail fix 4 mortars, ſo as to ſtand exactly in the middle of the intervals of them on the bottom rail; on the third rail place 3 mortars; on the fourth, 2; and on the top of the poſts, 1: the bottom rail muſt be 6 feet long: all the mortars muſt incline a little forwards, that they may eaſily diſcharge; and the ſpur-fires rammed exactly alike, that the mortars may all be fired at the ſame time. Having prepared your pyramid according to the preceding directions, carry pipes of communication from one ſpur-fire to the other.

127. *The illumimated Regulating Piece.*

Fig. 6. repreſents one half of this piece. A, A, A, A, are flat wooden ſpokes, each 5 feet long: at the end of each place a vertical wheel, 10 inches diameter, clothed with 6 four-ounce caſes of brilliant fire: theſe caſes muſt burn but 1 at a time: on two of the ſpokes of each wheel place 2 port-fires, which muſt be lighted with the firſt caſe of the wheel; on each ſpoke A, A, &c. behind the wheels, place 6 caſes of the ſame ſize with thoſe on the wheels: theſe caſes muſt be tied acroſs the ſpokes with their mouths all one way, and be made to take fire ſucceſſively one after the other, ſo that they may aſſiſt the whole pieces to turn round.

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The diameter of the large wheel muſt be $2\frac{1}{2}$ feet; and its fell made of wood, which muſt be fixed to the large ſpokes: on this wheel place 24 caſes of the ſame ſort with thoſe on the ſmall wheels; theſe caſes muſt burn 4 at a time: in this wheel make 3 circles with iron wire, and on them place illuminating port-fires, as in the figure: the ſtar-points on the large ſpokes may be made of thin aſh-hoops; the diameter of theſe points cloſe to the centre-wheel muſt be 11 inches: on theſe points place port-fires, at $3\frac{1}{2}$ inches diſtance one from the other.

Fig. 7. repreſents the blocks of this piece. The diameters of theſe blocks, at A and B, muſt be 8 inches; and C and D, $4\frac{1}{2}$ inches: the length of each of theſe blocks muſt be 6 inches: at the ſmall ends of theſe blocks fix an iron wheel 5 inches diameter, which wheels muſt have teeth, to turn the wheel E: this wheel is fixed on a ſmall ſpindle ſcrewed into the large ſpindle, which goes through the two blocks, and on which they run.

Suppoſing fig. 6. to be on the block A, in fig. 7. and to turn to the right, and another piece of the ſame conſtruction on the block B, with its fires placed ſo as to turn it to the left; you will find them move very true and faſt, by the help of the 3 iron wheels, which ſerve to regulate their motions, as well as to aſſiſt them in turning: let the iron circles in the front of the great wheels be of different diameters, ſo that when fired there may appear 6 circles. When this piece is fired, all the wheels and illuminations muſt be lighted at one time.

Sect. VI. *Aquatic Fire-works.*

Works that ſport in the water are much eſteemed by moſt admirers of fire-works, particularly water-rockets; and as they ſeem of a very extraordinary nature to thoſe who are unacquainted with this art, they merit a particular explanation.

128. *Water-rockets,*

May be made from 4 oz. to 2 lb. If larger, they are too heavy; ſo that it will be difficult to make them keep above water without a cork float, which muſt be tied to the neck of the caſe; but the rockets will not dive ſo well with as without floats.

Caſes for theſe are made in the ſame manner and proportion as ſky-rockets, only a little thicker of paper. When you fill thoſe which are drove ſolid, put in firſt 1 ladleful of ſlow fire, then 2 of the proper charge, and on that 1 or 2 ladles of ſinking charge, then the proper charge, then the ſinking charge again, and ſo on, till you have filled the caſe within 3 diameters; then drive on the compoſition 1 ladleful of clay; through which make a ſmall hole to the charge; then fill the caſe, within $\frac{1}{2}$ a diameter, with corn-powder, on which turn down 2 or 3 rounds of the caſe in the inſide; then pinch and tie the end very tight; having filled your rockets (according to the above directions), dip their ends in melted roſin or ſealing wax, or elſe ſecure them well with greaſe. When you fire thoſe rockets, throw in 6 or 8 at a time; but, if you would have them all ſink, or ſwim, at the ſame time,

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time, you must drive them with an equal quantity of compoſition, and fire them all together.

129. *To make Pipes of Communication, which may be uſed under Water.*

Pipes for this purpoſe muſt be a little thicker of paper than thoſe for land. Having rolled a ſufficient number of pipes, and kept them till dry, waſh them over with drying oil, and ſet them to dry; but when you oil them, leave about 1½ inch at each end dry, for joints: if they were oiled all over, when you come to join them, the paſte would not ſtick where the paper is greaſy: after the leaders are joined, and the paſte dry, oil the joints. Theſe pipes will lie many hours under water, without receiving any damage.

130. *Horizontal Wheels for the Water.*

Firſt get a large wooden bowl without a handle; then have an octagon wheel made of a flat board 18 inches diameter, ſo that the length of each ſide will be near 7 inches: in all the ſides cut a groove for the caſes to lie in. This wheel being made, nail it on the top of the bowl; then take 4-eight oz. caſes, filled with a proper charge, each about 6 inches in length. Now, to clothe the wheel with theſe caſes, get ſome whitiſh-brown paper, and cut it into ſlips 4 or 5 inches broad and 7 or 8 long: theſe ſlips being paſted all over on one ſide, take one of the caſes, and roll one of the ſlips of paper about 1½ inch on its end, ſo that there will remain about 2½ inches of the paper hollow from the end of the caſe: this caſe tie on one of the ſides of the wheel, near the corners of which muſt be holes bored, through which you put the packthread to tie the caſes: having tied on the firſt caſe at the neck and end, put a little meal-powder in the hollow paper; then paſte a ſlip of paper on the end of another caſe, the head of which put into the hollow paper on the firſt, allowing a ſufficient diſtance from the tail of one to the head of the other for the paſted paper to bend without tearing: the ſecond caſe tie on as you did the firſt: and ſo on with the reſt, except the laſt, which muſt be cloſed at the end, unleſs it is to communicate to any thing on the top of the wheel, ſuch as fire-pumps or brilliant fires, fixed in holes cut in the wheel, and fired by the laſt or ſecond caſe, as the fancy directs: 6, 8, or any number, may be placed on the top of the wheel, provided they be not too heavy for the bowl.

Before you tie on the caſes, cut the upper part of all their ends, except the laſt, a little ſhelving, that the fire from one may play over the other, without being obſtructed by the caſe. Wheel-caſes have no clay drove in their ends, nor pinched, but are always left open, only the laſt, or thoſe which are not to lead fire, which muſt be well ſecured.

131. *Water Mines.*

For theſe mines you muſt have a bowl with a wheel on it, made in the ſame manner as the water-wheel; only in its middle there muſt be a hole, of the ſame diameter you deſign to have the mine. Theſe mines are tin pots, with ſtrong bottoms, and a little more than 2 diameters in length: your mine muſt be fixed in the hole in the wheel, with its bottom reſting on the bowl; then loaded with ſerpents, crackers, ſtars, ſmall water-rockets, &c. in the ſame manner as pots of aigrettes; but in their centre fix a caſe of Chineſe fire, or a ſmall gerbe, which muſt be lighted at the beginning of the laſt caſe on the wheel. Theſe wheels are to be clothed as uſual.

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132. *Fire-globes for the Water.*

Bowls for water-globes muſt be very large, and the wheels on them of a decagon form: on each ſide of which nail a piece of wood 4 inches long; and on the outſide of each piece cut a groove, wide enough to receive about ¼ of the thickneſs of a 4-oz. caſe: theſe pieces of wood muſt be nailed in the middle of each face of the wheel, and fixed in an oblique direction, ſo that the fire from the caſes may incline upwards: the wheel being thus prepared, tie in each groove a 4-oz. caſe, filled with a grey charge; then carry a leader from the tail of one caſe to the mouth of the other.

Globes for theſe wheels are made of 2 tin hoops, with their edges outwards, fixed one within the other, at right angles. The diameter of theſe hoops muſt be ſomewhat leſs than that of the wheel. Having made a globe, drive in the centre of a wheel an iron ſpindle, which muſt ſtand perpendicular, and its length 4 or 6 inches more than the diameter of the globe.

This ſpindle ſerves for an axis, on which the globe is fixed, which, when done, muſt ſtand 4 or 6 inches from the wheel: round one ſide of each hoop muſt be ſoldered little bits of tin, 2½ inches diſtance from each other; which pieces muſt be 2 inches in length each, and only faſtened at one end, the other ends being left looſe, to turn round the ſmall port-fires, and hold them on: theſe port-fires muſt be made of ſuch a length as will laſt out the caſes on the wheel. You are to obſerve, that there need not be any port-fires at the bottom of the globe within 4 inches of the ſpindle; for, if there were, they would have no effect, but only burn the wheel: all the port-fires muſt be placed perpendicular from the centre of the globe, with their mouths outwards; and muſt all be clothed with leaders, ſo as all to take fire with the ſecond caſe of the wheel; which caſes muſt burn two at a time, one oppoſite the other. When two caſes of a wheel begin together, two will end together; therefore the two oppoſite end caſes muſt have their ends pinched and ſecured from fire. The method of firing ſuch wheels is, by carrying a leader from the mouth of one of the firſt caſes to that of the other; which leader being burnt through the middle, will give fire to both at the ſame time.

133. *Odoriferous Water Balloons.*

Theſe balloons are made in the ſame manner as air-balloons, but very thin of paper, and in diameter 1½ inch, with a vent of ½ inch diameter. The ſhells being made, and quite dry, fill them with any of the following compoſitions, which muſt be rammed in tight: theſe balloons muſt be fired at the vent, and put into a bowl of water. Odoriferous works are generally fired in rooms.

Compoſition I. Saltpetre 2 oz. flour of ſulphur 1 oz. camphor ½ oz. yellow amber ½ oz. charcoal-duſt ¾ oz. flour of benjamin or aſſa odorata ½ oz. all powdered very fine and well mixed.

II. Saltpetre 12 oz. meal-powder 3 oz. frankincenſe 1 oz. myrrh ½ oz. camphor ½ oz. charcoal 3 oz. all moiſtened with the oil of ſpike.

III. Saltpetre 2 oz. ſulphur ½ oz. antimony ½ oz. amber ½ oz. cedar raſpings ½ oz. all mixed with the oil of roſes and a few drops of bergamot.

IV.

Aquatic Fire-works.

IV. Saltpetre 4 oz. ſulphur 1 oz. ſaw-duſt of juniper ½ oz. ſaw-duſt of cypreſs 1 oz. camphor ¼ oz. myrrh 2 drams, dried roſemary ¼ oz. cortex elaterii ½ oz. all moiſtened a little with the oil of roſes.

N. B. Water rockets may be made with any of the above compoſitions, with a little alteration, to make them weaker or ſtronger, according to the ſize of the caſes.

134. *Water Balloons.*

Having made ſome thin paper ſhells, of what diameter you pleaſe, fill ſome with the compoſition for water balloons, and ſome after this manner: Having made the vent of the ſhells pretty large, fill them almoſt full with water rockets, marrons, ſquibs, &c. Then put in ſome blowing powder, ſufficient to burſt the ſhells; and afterwards fix in the vent a water-rocket, long enough to reach the bottom of the ſhell, and its neck to project a little out of the vent; this rocket muſt be open at the end, to fire the powder in the ſhell, which will burſt the ſhell, and diſperſe the ſmall rockets, &c. in the water. When you have well ſecured the large rocket in the vent of the ſhell, take a cork float with a hole in its middle, which fit over the head of the rocket, and faſten it to the ſhell: this float muſt be large enough to keep the balloon above water.

135. *Water Squibs*

Are generally made of 1-oz. ſerpent caſes ſeven or eight inches long, filled two thirds with charge, and the remainder bounced. The common method of firing them is this: Take a water-wheel, with a tin mortar in its centre, which load with ſquibs after the uſual method; but the powder in the mortar muſt be no more than will juſt throw the ſquibs out eaſily into the water: you may place the caſes on the wheel either obliquely or horizontally; and on the top of the wheel, round the mortar, fix ſix caſes of brilliant fire perpendicular to the wheel: theſe caſes muſt be fired at the beginning of the laſt caſe of the wheel, and the mortar at the concluſion of the ſame.

136. *A Sea-fight with ſmall Ships, and to prepare a Fire-ſhip for it.*

Having procured four or five ſmall ſhips, of two or three feet in length, (or as many as you deſign to fight), make a number of ſmall reports, which are to ſerve for guns. Of theſe range as many as you pleaſe on each ſide of the upper decks; then at the head and ſtern of each ſhip fix a two-ounce caſe, eight inches long, filled with a ſlow port-fire receipt; but take care to place it in ſuch a manner that the fire may fall in the water, and not burn the rigging: in theſe caſes bore holes at unequal diſtances from one another, but make as many in each caſe as half the number of reports, ſo that one caſe may fire the guns on one ſide, and the other thoſe on the oppoſite. The method of firing the guns is, by carrying a leader from the holes in the caſes to the reports on the decks; you muſt make theſe leaders very ſmall, and be careful in calculating the burning of the ſlow-fire in the regulating caſes, that more than two guns be not fired at a time. When you would have a broadſide given, let a leader be carried to a cracker, placed on the outſide of the ſhip; which cracker muſt be tied looſe, or the reports will be too ſlow: in all the ſhips put artificial guns at the port-holes.

Having filled and bored holes in two port-fires for regulating the guns in one ſhip, make all the reſt exactly the ſame; then, when you begin the engagement, light one ſhip firſt, and ſet it a ſailing, and ſo on with the reſt, ſending them out ſingly, which will make them fire regularly, at different times, without confuſion; for the time between the firing of each gun will be equal to that of lighting the ſlow fires. Aquatic Fire-works.

The fire-ſhip may be of any ſize; and need not be very good, for it is always loſt in the action. To prepare a ſhip for this purpoſe, make a port-fire equal in ſize with thoſe in the other ſhips, and place it at the ſtern; in every port place a large port-fire, filled with a very ſtrong compoſition, and painted in imitation of a gun, and let them all be fired at once by a leader from the ſlow fire, within two or three diameters of its bottom; all along both ſides, on the top of the upper deck, lay ſtar-compoſition about half an inch thick and one broad, which muſt be wetted with thin ſize, then primed with meal-powder, and ſecured from fire by paſting paper over it; in the place where you lay this compoſition, drive ſome little tacks with flat heads, to hold it faſt to the deck: this muſt be fired juſt after the ſham guns, and when burning will ſhow a flame all round the ſhip: at the head take up the decks, and put in a tin mortar loaded with crackers, which mortar muſt be fired by a pipe from the end of the ſlow fire; the firing of this mortar will ſink the ſhip, and make a pretty concluſion. The regulating port-fire of this ſhip muſt be lighted at the ſame time with the firſt fighting ſhip.

Having prepared all the ſhips for fighting, we ſhall next proceed with the management of them when on the water. At one end of the pond, juſt under the ſurface of the water, fix two running blocks, at what diſtance you chooſe the ſhips ſhould fight; and at the other end of the pond, oppoſite to each of theſe blocks, under the water, fix a double block; then on the land, by each of the double blocks, place two ſmall windlaſſes; round one of them turn one end of a ſmall cord, and the other end put through one of the blocks; then carry it through the ſingle one at the oppoſite end of the pond, and bring it back through the double block again, and round the other windlaſs: to this cord, near the double block, tie as many ſmall ſtrings as half the number of the ſhips, at what diſtance you think proper; but theſe ſtrings muſt not be more than two feet each: make faſt the looſe end of each to a ſhip, juſt under her bow-ſprit; but if tied to the keel, or too near the water, it will overſet the ſhip. Half the ſhips being thus prepared, near the other double block fix two more windlaſſes, to which faſten a cord, and to it tie the other half of the ſhips as before: when you fire the ſhips, pull in the cord with one of the windlaſſes, to get all the ſhips together; and when you have ſet fire to the firſt, turn that windlaſs which draws them out, and ſo on with the reſt, till they are all out in the middle of the pond; then, by turning the other windlaſs, you will draw them back again; by which method you may make them change ſides, and tack about backwards and forwards at pleaſure. For the fire-ſhip, fix the blocks and windlaſſes between the others; ſo that when ſhe ſails out, ſhe will be between the other ſhips: you muſt not let this ſhip advance till the guns at her ports take fire.

137. *To fire Sky-rockets under Water,*

You muſt have ſtands made as uſual, only the rails muſt

Aquatic Fire-works.

must be placed flat inſtead of edgewiſe, and have holes in them for the rocket-ſticks to go through; for if they were hung upon hooks, the motion of the water would throw them off: the ſtands being made, if the pond is deep enough, ſink them at the ſides ſo deep, that, when the rockets are in, their heads may juſt appear above the ſurface of the water; to the mouth of each rocket fix a leader, which put through the hole with the ſtick; then a little above the water muſt be a board, ſupported by the ſtand, and placed along one ſide of the rockets; then the ends of the leaders are turned up through holes made in this board, exactly oppoſite the rockets. By this means you may fire them ſingly or all at once. Rockets may be fired by this method in the middle of a pond, by a Neptune, a ſwan, a water-wheel, or any thing elſe you chooſe.

138. *To repreſent Neptune in his Chariot.*

To do this to perfection, you muſt have a Neptune (made of wood, or baſket work) as big as life, fixed on a float large enough to bear his weight; on which muſt be two horſes heads and necks, ſo as to ſeem ſwimming, as ſhown by fig. 11. For the wheels of the chariot, there muſt be two vertical wheels of black fire, and on Neptune's head a horizontal wheel of brilliant fire, with all its caſes, to play upwards. When this wheel is made, cover it with paper or paſte-board, cut and painted like Neptune's coronet; then let the trident be made without prongs, but inſtead of them, fix three caſes of a weak grey charge, and on each horſe's head put an eight ounce caſe of brilliant fire, and on the mouth of each fix a ſhort caſe, of the ſame diameter, filled with the white-flame receipt, enough to laſt out all the caſes on the wheels: theſe ſhort caſes muſt be open at bottom, that they may light the brilliant fires; for the horſes eyes put ſmall port-fires, and in each noſtril put a ſmall caſe filled half with grey charge, and the reſt with port-fire compoſition.

If Neptune is to give fire to any building on the water; at his firſt ſetting out, the wheels of the chariot, and that on his head, with the white flames on the horſes heads, and the port-fires in their eyes and noſtrils, muſt all be lighted at once; then from the bottom of the white flames carry a leader to the trident. As Neptune is to advance by the help of a block and cord, you muſt manage it ſo as not to let him turn about, till the brilliant fires on the horſes and the trident begin; for it is by the fire from the horſes (which plays almoſt upright) that the building, or work, is lighted; which muſt be thus prepared. From the mouth of the caſe which is to be firſt fired, hang ſome looſe quick-match to receive the fire from the horſes. When Neptune is only to be ſhown by himſelf, without ſetting fire to any other works, let the white flames on the horſes be very ſhort, and not to laſt longer than one caſe of each wheel, and let two caſes of each wheel burn at a time.

Aquatic Fire-works.

139. *Swans and Ducks in Water.*

If you would have the ſwans or ducks diſcharge rockets into the water, they muſt be made hollow, and of paper, and filled with ſmall water rockets, with ſome blowing powder to throw them out: but if this is not done, they may be made of wood, which will laſt many times. Having made and painted ſome ſwans, fix them on floats: then in the places where their eyes ſhould be, bore holes two inches deep, inclining downwards, and wide enough to receive a ſmall port-fire; the port-fire caſes for this purpoſe muſt be made of braſs, two inches long, and filled with a ſlow bright charge. In the middle of one of theſe caſes make a little hole; then put the port-fire in the eye-hole of the ſwan, leaving about half an inch to project out; and in the other eye put another port-fire, with a hole made in it: then in the neck of the ſwan, within two inches of one of the eyes, bore a hole ſlantwiſe, to meet that in the port-fire; in this hole put a leader, and carry it to a water-rocket, that muſt be fixed under the tail with its mouth upwards. On the top of the head place two 1-oz. caſes, four inches long each, drove with brilliant fire; one of theſe caſes muſt incline forwards, and the other backwards: theſe muſt be lighted at the ſame time as the water-rocket; to do which, bore a hole between them in the top of the ſwan's head, down to the hole in the port-fire, to which carry a leader: if the ſwan is filled with rockets, they muſt be fired by a pipe from the end of the water-rocket under the tail. When you ſet the ſwan a ſwimming, light the two eyes.

140. *Water Fire-fountains.*

To make a fire-fountain, you muſt firſt have a float made of wood, three feet diameter; then in the middle fix a round perpendicular poſt, four feet high, and two inches diameter; round this poſt fix three circular wheels made of thin wood, without any ſpokes. The largeſt of theſe wheels muſt be placed within two or three inches of the float, and muſt be nearly of the ſame diameter. The ſecond wheel muſt be 2 feet 2 inches diameter, and fixed at two feet diſtance from the firſt. The third wheel muſt be 1 foot 4 inches diameter, and fixed within ſix inches of the top of the poſt: the wheels being fixed, take 18 four or eight oz. caſes of brilliant fire, and place them round the firſt wheel with their mouths outwards, and inclining downwards; on the ſecond wheel place 13 caſes of the ſame, and in the ſame manner as thoſe on the firſt; on the third, place 8 more of theſe caſes, in the ſame manner as before, and on the top of the poſt fix a gerbe; then clothe all the caſes with leaders, ſo that both they and the gerbe may take fire at the ſame time. Before you fire this work, try it in the water to ſee if the float is properly made, ſo as to keep the fountain upright.

P Y R

PYROTICS, in medicine, cauſtics, or remedies either actually or potentially hot; and which accordingly will burn the fleſh, and raiſe an eſchar. See CAUSTICITY.

PYRRHICHA, in antiquity, a kind of exerciſe on horſeback, or a feigned combat, for the exerciſe of the cavalry.

It was thus called from its inventor Pyrrhichus, or Pyrrhus of Cydonia, who firſt taught the Cretans to march in meaſure and cadence to battle, and to obſerve

Pyrrhichius || Pyrus.

serve the pace of the Pyrrhic foot.—Others derive the name from Pyrrhus the ſon of Achilles, who inſtituted this exerciſe at the obſequies of his father.—Ariſtotle ſays, that it was Achilles himſelf who invented it.

The Romans alſo called it *ludus Trojanus*, "the Trojan game;" and Aulus Gellius, *decurſus*.—It is doubtleſs this exerciſe that we ſee repreſented on medals by two cavaliers in front running with lancets, and the word *decurſio* in the exergum.

PYRRHICHIUS, in the Greek and Latin poetry, a foot conſiſting of two ſyllables, both ſhort;—as, *Deus*.—Among the ancients this foot is alſo called *periambus*; by others *hegemona*.

PYRRHO, a Greek philoſopher, born at Elis in Peloponneſus, flouriſhed about 300 B. C. He was the diſciple of Anaxarchus, whom he accompanied as far as India, where he converſed with the Brachmans and Gymnoſophiſts. He had made painting his profeſſion before he devoted himſelf to the ſtudy of philoſohpy. He eſtabliſhed a ſect whoſe fundamental principle was, That there is nothing true or falſe, right or wrong, honeſt or diſhoneſt, juſt or unjuſt; or that there is no ſtandard of any thing beyond law or cuſtom, and that uncertainty and doubt belong to ever thing. From this continual ſeeking after truth and never finding it, the ſect obtained the name of *Sceptics* or *Pyrrhonians* from the founder, who is ſaid to have acted upon his own principles, and to have carried his ſcepticiſm to ſuch a ridiculous extreme, that his friends were obliged to accompany him wherever he went, that he might not be run over by carriages, or fall down precipices. If this was true, it was not without reaſon that he was ranked among thoſe whoſe intellects were diſturbed by intenſe ſtudy. But it is treated by a modern writer as a mere calumny invented by the dogmatiſts; and we are ſtrongly inclined to be of his opinion, (ſee SCEPTICS.) Pyrrho died about the 90th year of his age, when his memory was honoured with a ſtatue at Athens, and a monument erected to him in his own country.

PYRRHUS, the name of two kings of EPIRUS. See that article.

PYRUS, the PEAR-TREE: A genus of the pentagynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 36th order, *Pomaceæ*. The calyx is quinquefid; there are five petals; the fruit is an apple, inferior, quinquelocular, and polyſpermous. To this genus Linnæus has joined the apple and quince; but, on account of the remarkable difference between the fruits, the laſt is treated under the article CYDONIA. The other ſpecies are,

1. The communis, or common pear-tree, riſes with an upright large trunk, branching 30 or 40 feet high, in ſome widely around, in others more erectly, and forming a conical head; oval, lanceolated, ſerrated leaves, and corymbous cluſters of white flowers from the ſides of the branches, ſucceeded by large fruit extended at the baſe. Under this ſpecies are comprehended almoſt endleſs varieties, all bearing the above deſcription. They bear their flowers and fruit upon ſpurs, ariſing from the ſides of the branches from two or three years old and upwards; the ſame branches and ſpurs continuing fruitful for a great number of years. The different varieties furniſh fruit for uſe from the beginning of July till the months of May and June, next year; which, according to their times of ripening may be divided into three claſſes, ſummer-pears, autumn-pears, and winter-pears. The ſummer-pears ripen in different ſorts from the beginning of July until the middle or end of September, and are generally fit to eat from the tree, or at leaſt do not keep a week or two before they rot. The autumn pears come to their perfection in October, November, and December; ſome ripening nearly on the tree in October and the beginning of November, others requiring to lie ſome time in the fruitery, while ſome will keep two months: but all the winter-pears, though they attain their full growth on the tree by the end of October and in November, yet they do not acquire perfection for eating till from the end of November to April and May. Thoſe of each claſs have different properties; ſome being melting, others breaking, ſome mealy, and ſome hard and auſtere, fit only for kitchen uſes. As many of the fineſt ſorts were firſt obtained from France, they are ſtill continued in moſt catalogues by French names. Pyrus.

2. The malus, or common apple-tree, grows 20 or 30 feet high, having oval ſerrated leaves, and ſeſſile umbels of whitiſh red flowers, ſucceeded by large, roundiſh, and oblong fruit, concave at the baſe. The apple is compoſed of four diſtinct parts, viz. the pill, the parenchyma, the branchery, and the core. The pill or ſkin is only a dilatation of the outermoſt ſkin or rind of the bark of the branch on which it grew. The parenchyma or pulp, as tender and delicious as it is found, is only a dilatation, or, as Dr Grew calls it, *a ſwelth* or ſuperbience of the inner part of the bark of the branch. This appears not only from the viſible continuation of the bark from the one through the pedicle or ſtalk to the other, but alſo from the ſtructure common to both. The branchery or veſſels are only ramifications of the woody part of the branch, ſent throughout all the parts of the parenchyma, the greater branches being made to communicate with each other by inoſculations of the leſs. The apple core is originally from the pith of the branch; the ſap of which finding room enough in the parenchyma through which to diffuſe itſelf, quits the pith, which by this means hardens into core. The varieties of this ſpecies are amazingly great with reſpect to the differences of the fruit. The botaniſts contend, that the wilding, or crab-apple of the woods and hedges, is the original kind, and from the ſeeds of which the cultivated apple was firſt obtained. The varieties of this laſt no doubt are multiplied to ſome hundreds in different places, having been all firſt accidentally obtained from the ſeed or kernels of the fruit, and the approved ſorts continued and increaſed by grafting upon crabs or any kind of apple-ſtocks: but although the number of varieties is very conſiderable, there are not above 40 or 50 ſorts retained in the nurſerymens catalogue. Theſe varieties arrive at full growth in ſucceſſive order from July to the end of October, improve in perfection after being gathered; and ſeveral of the winter kinds, in particular, keep good for many months, even till the arrival of apples next ſummer.

Among theſe various kinds of apples ſome are uſed for the deſſert, ſome for the kitchen, and ſome for cyder-

PYROTECHNY.

Plate CCCCXXIX.

Fig. 1.

Fig. 2.

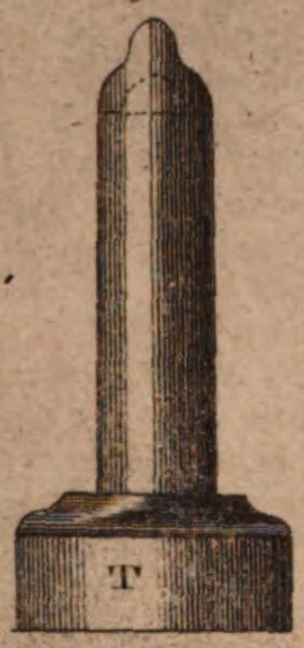


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

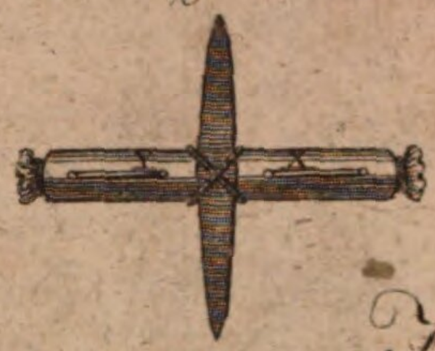


Fig. 7.

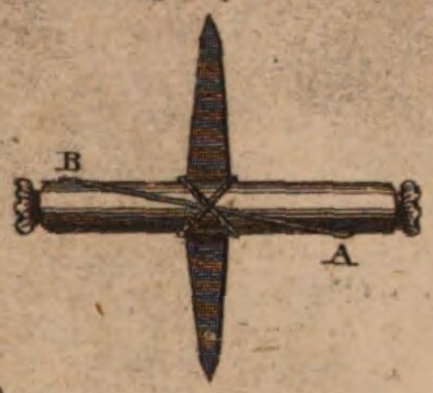
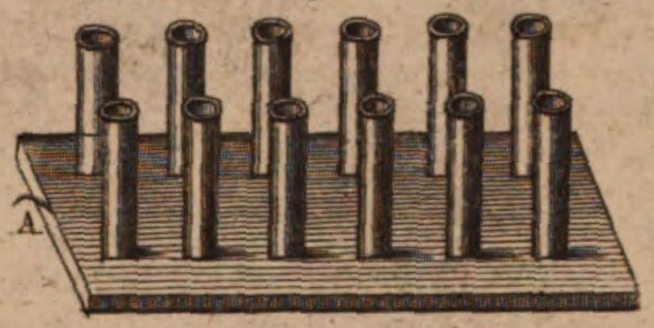


Fig. 8.

Fig. 9.



2d. Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

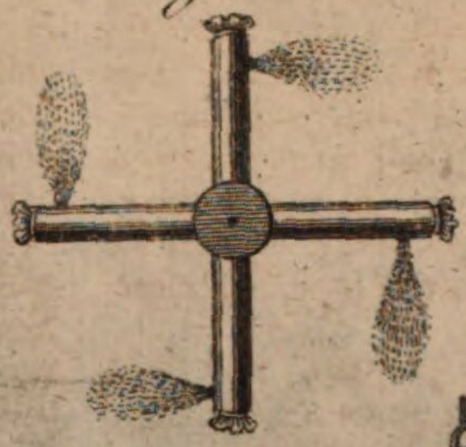


Fig. 15.

Fig. 16.

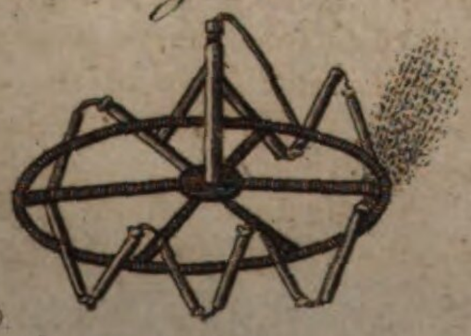
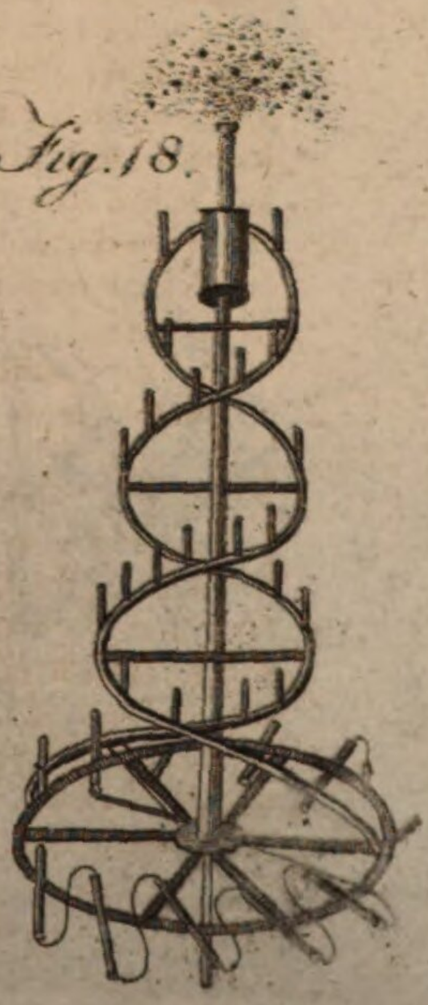


Fig. 17.

Fig. 18.



Abbott Print. Wat. Sculptor fecit.

PYROTECHNY.

Fig. 1.

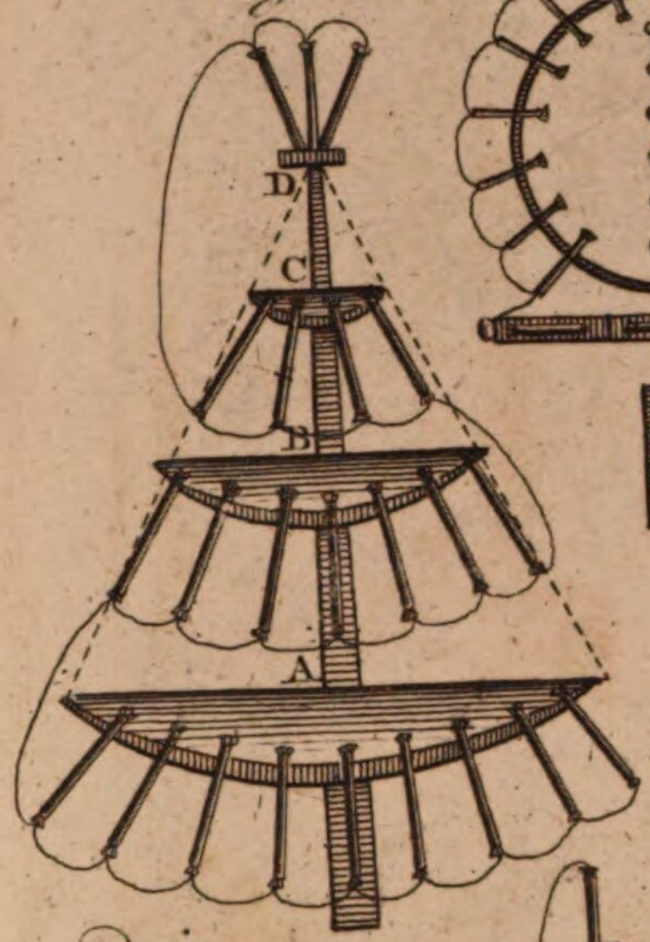


Fig. 4.

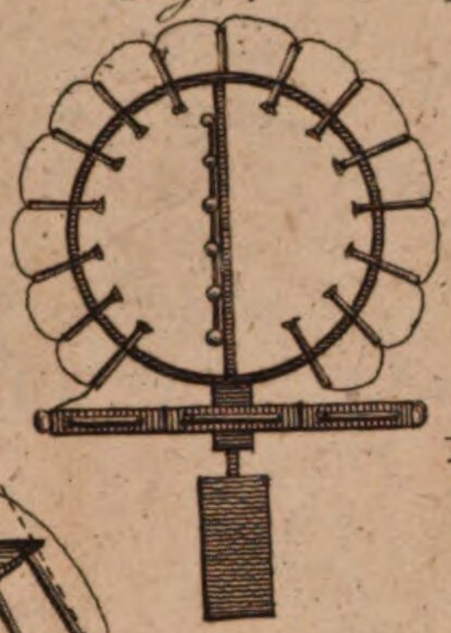


Fig. 6.

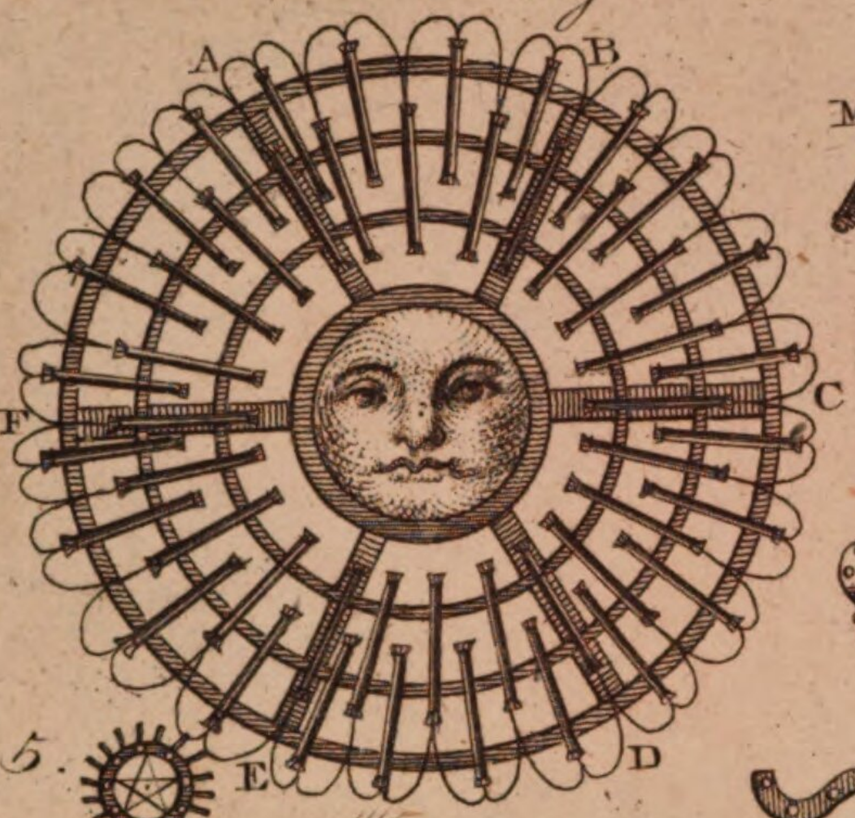


Fig. 7.

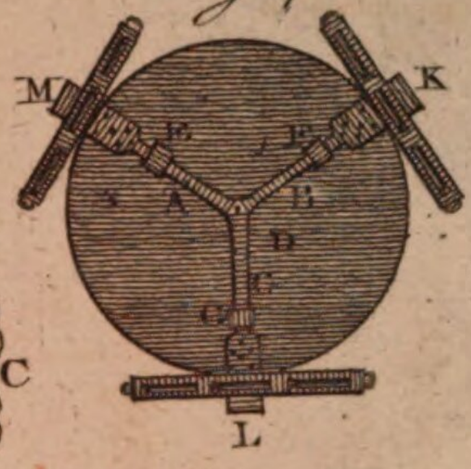
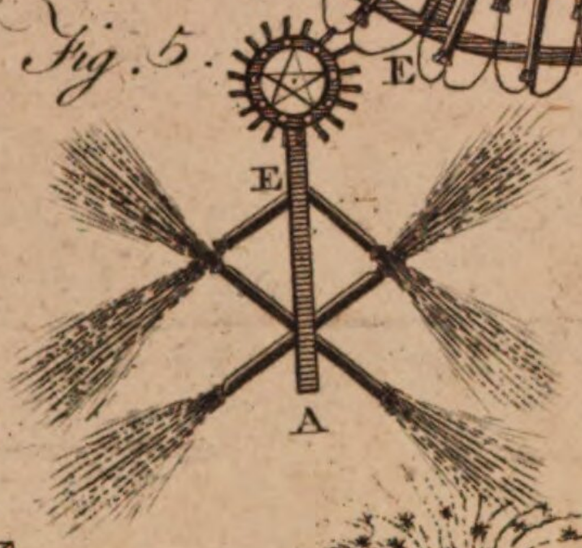


Fig. 5.



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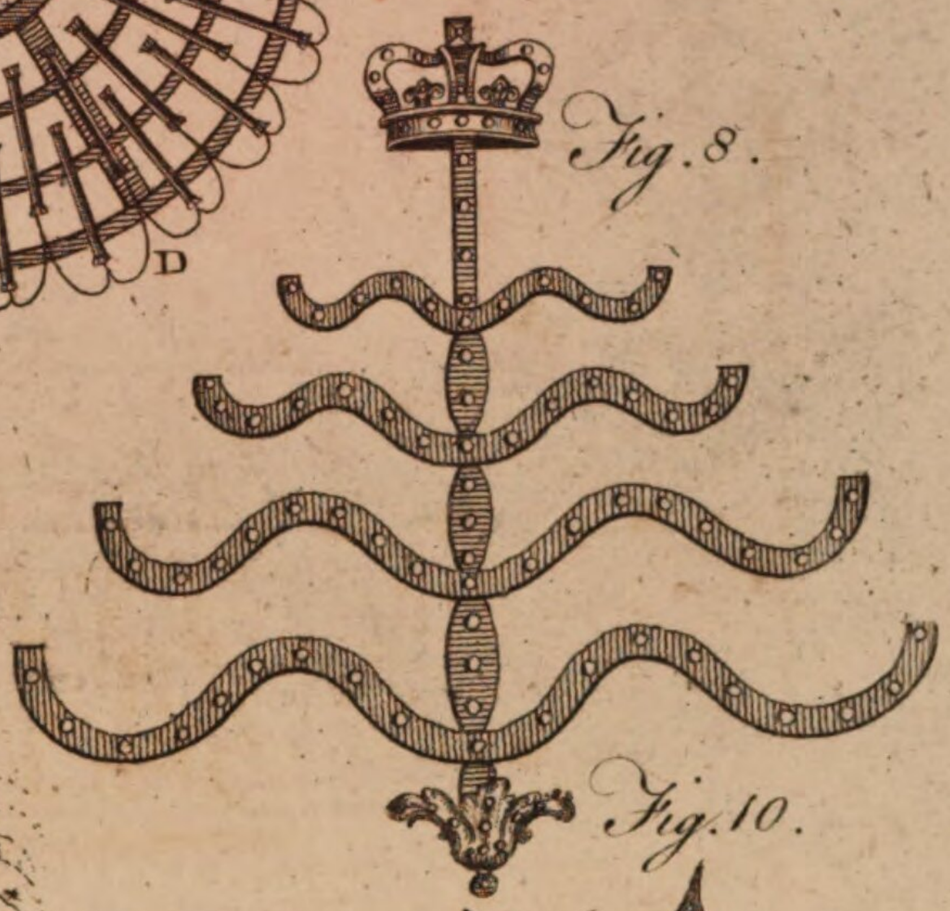

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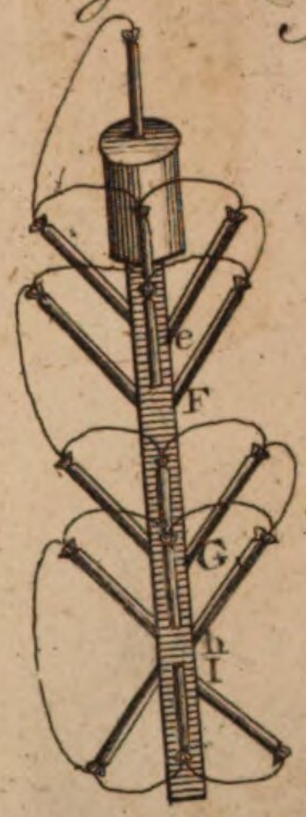

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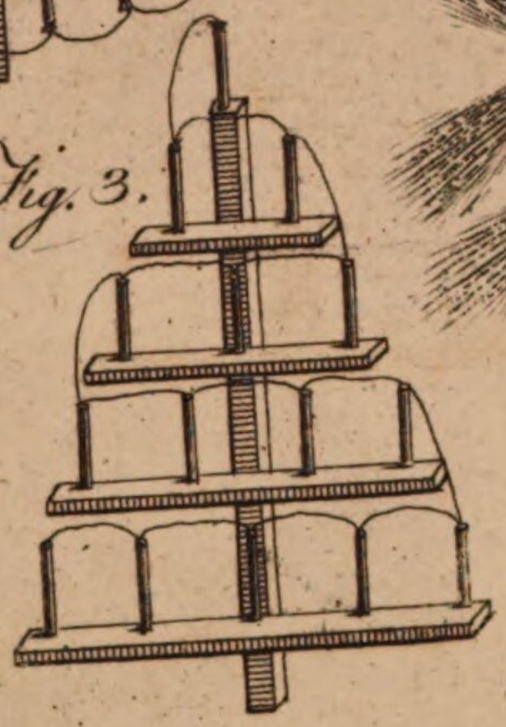
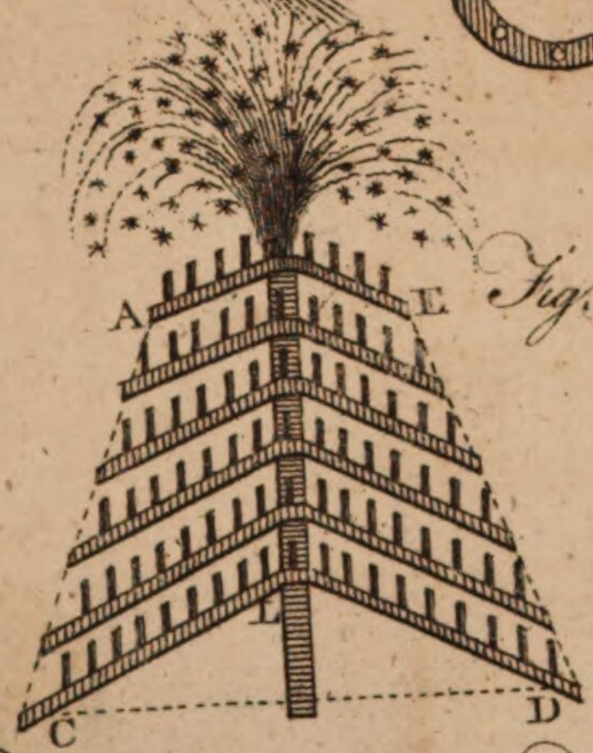


Fig. 10.

Fig. 9.



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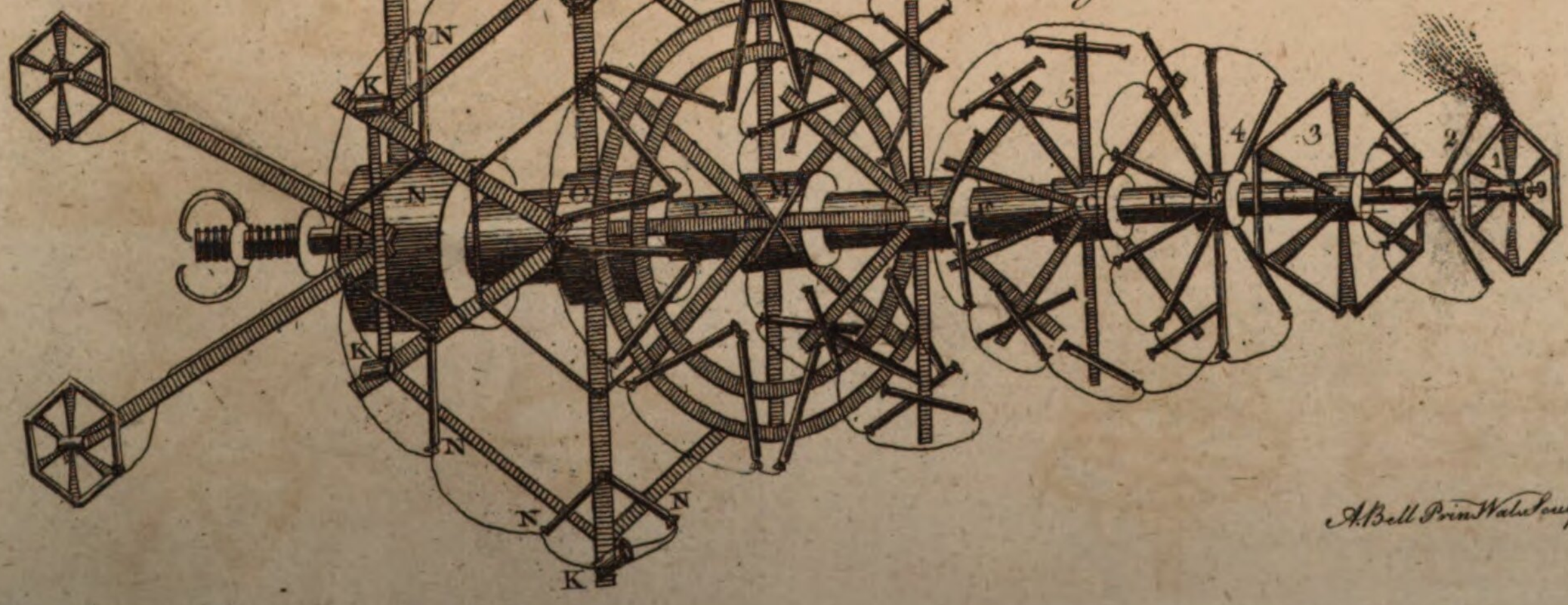


A Bell Printer Wakefield sculptor fecit

PYROTECHNY.

Plate CCCCXXXI.

Fig. 1.

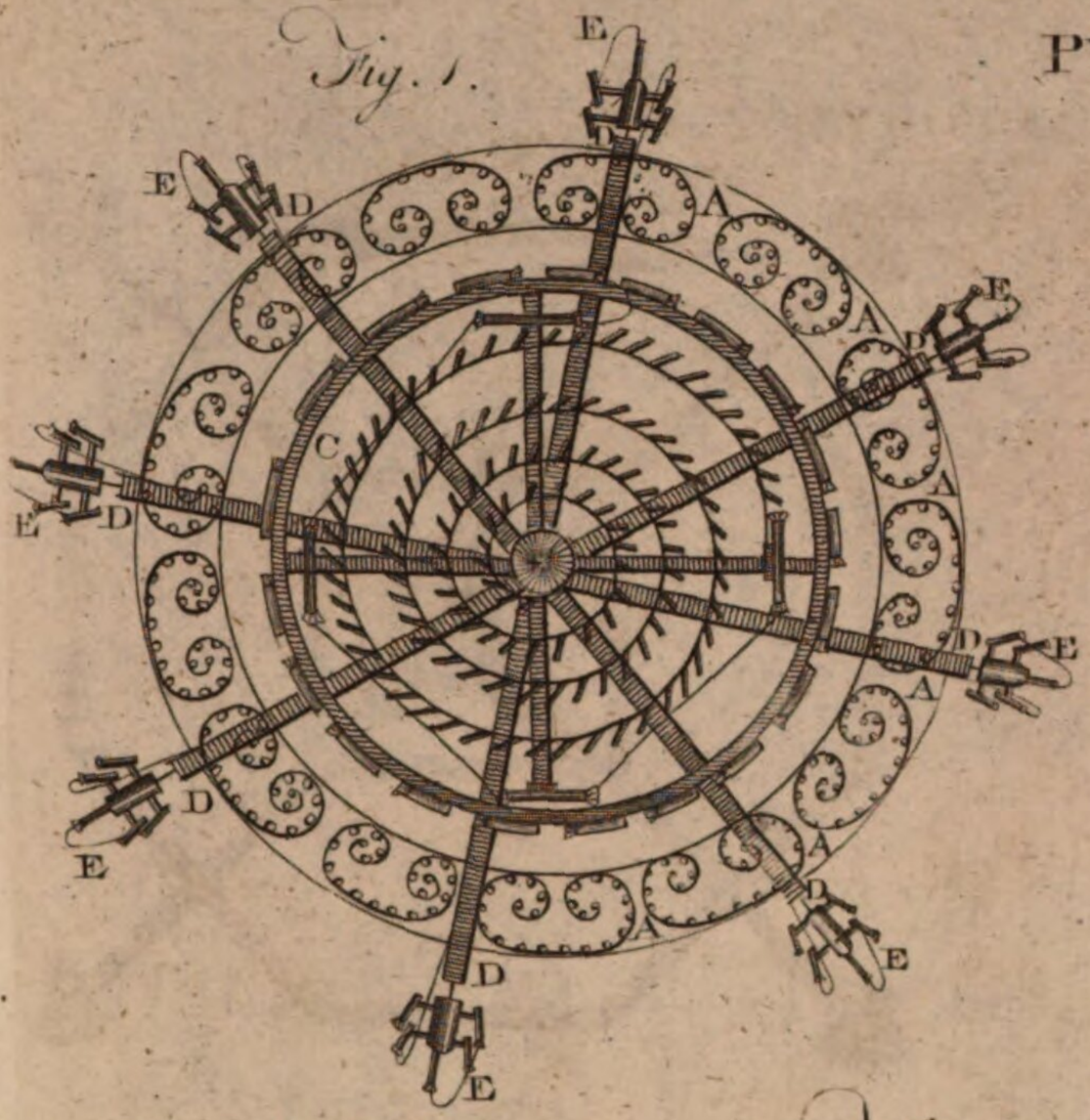


Fig. 2.

Fig. 3.

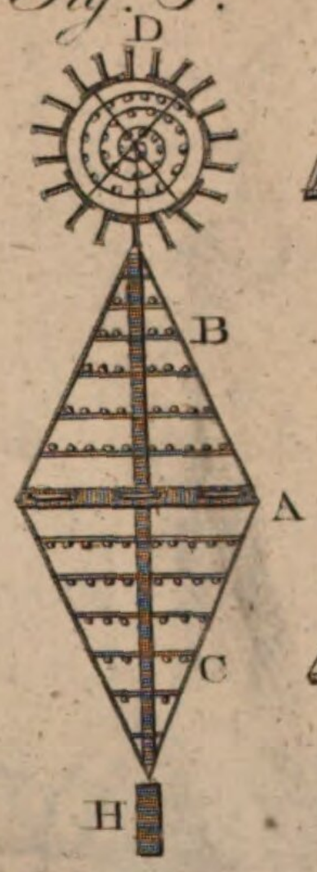
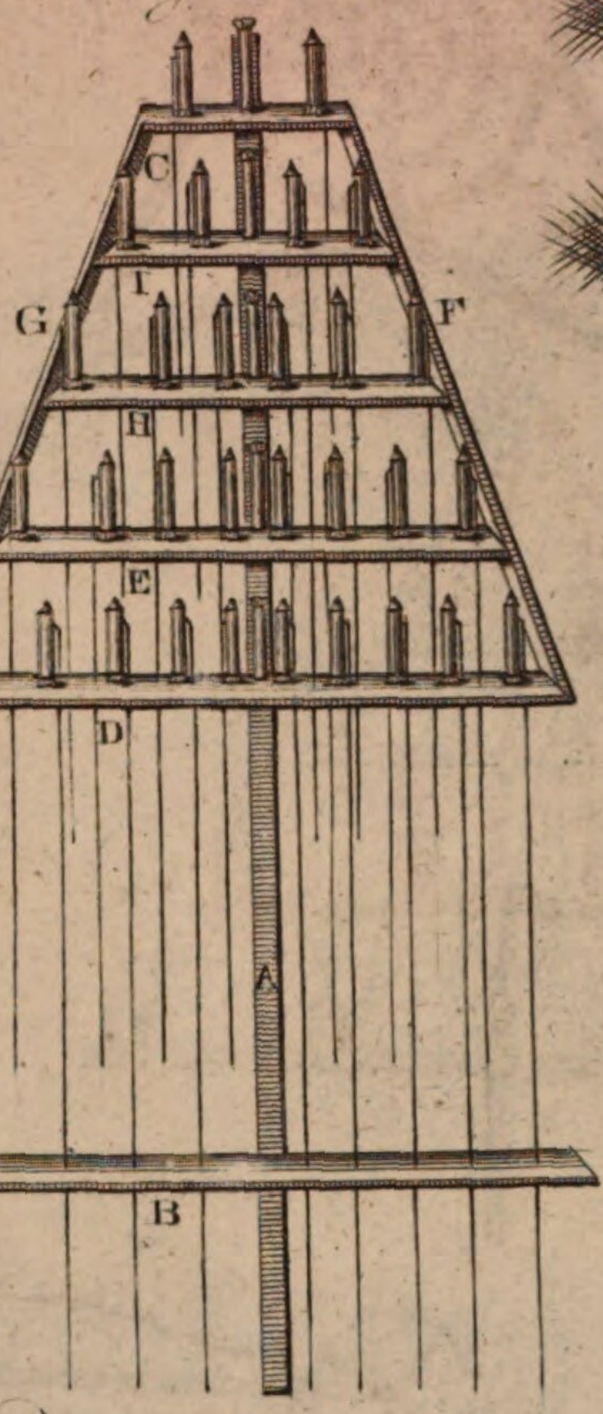


Fig. 4.

Fig. 5.



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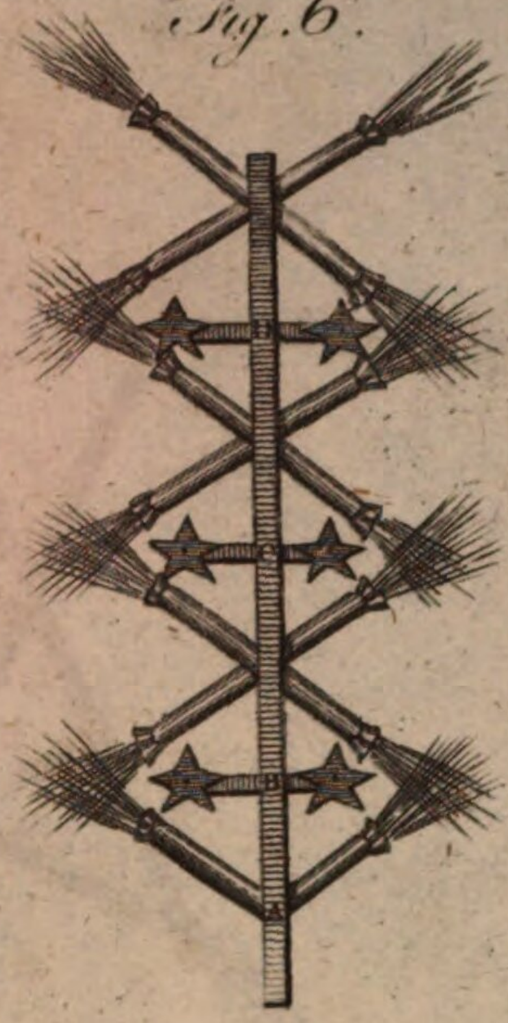

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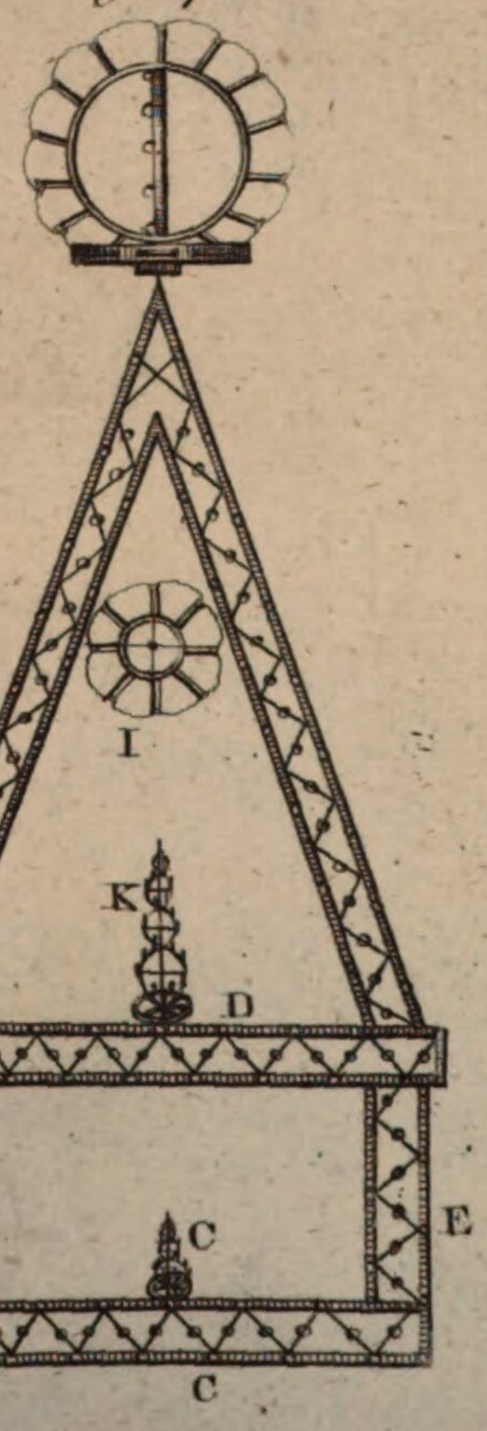

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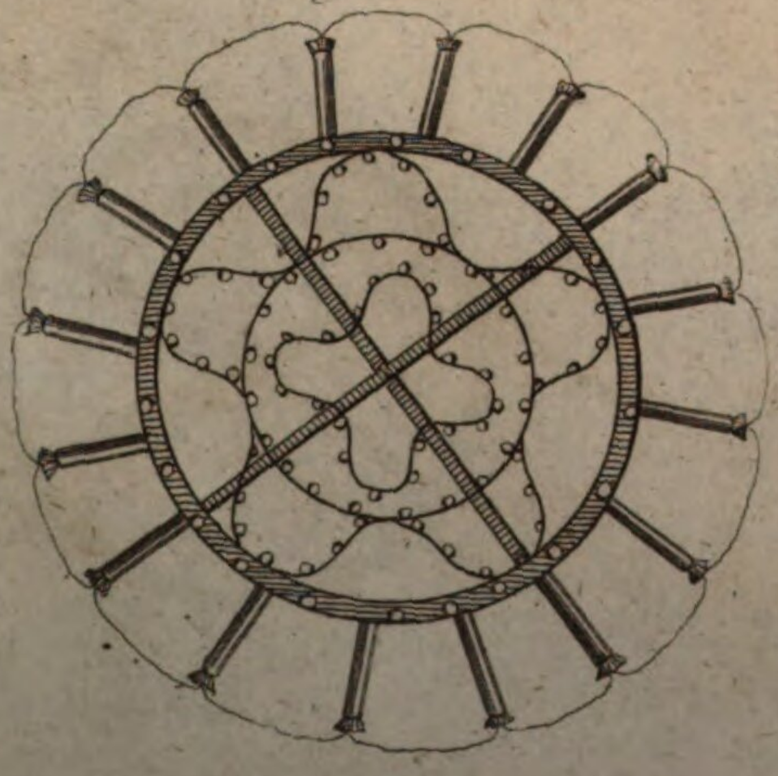
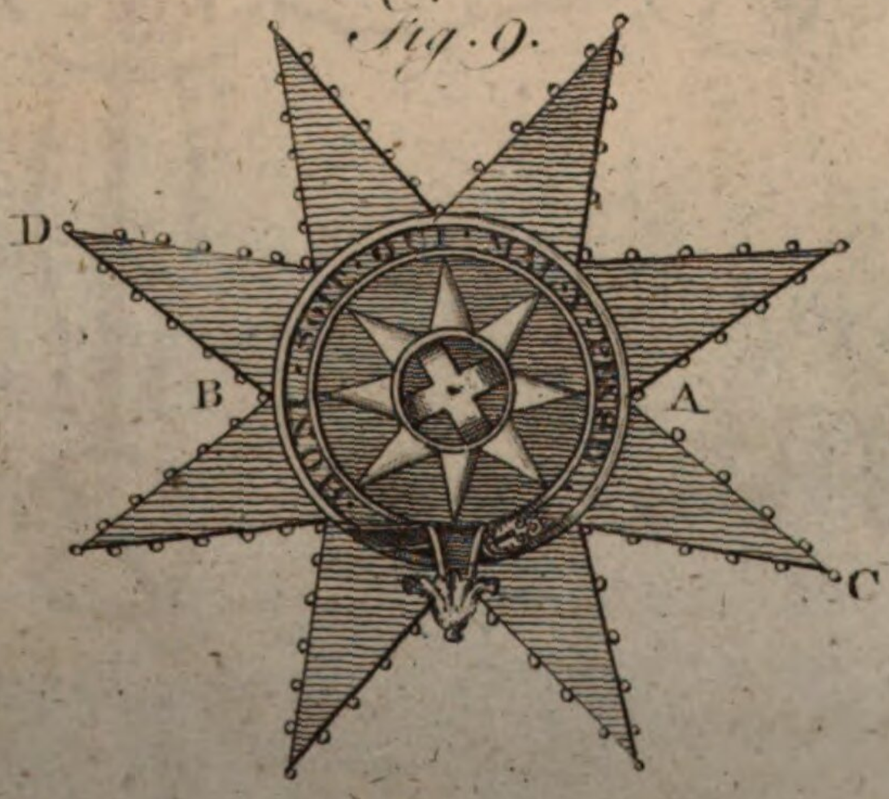


Fig. 9.



A Bell Prin. Wal. Sculptor fecit.

PYROTECHNY.

Plate CCCCXXXII.

Fig. 1.

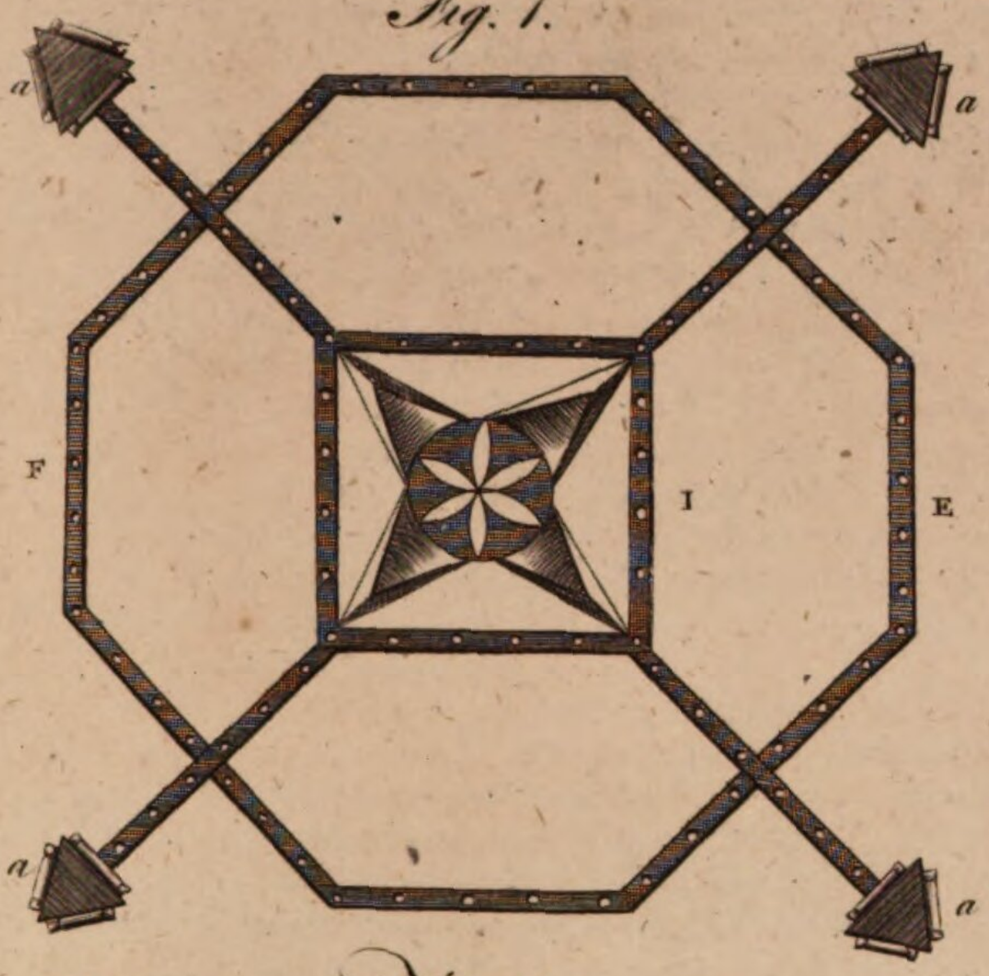


Fig. 2.

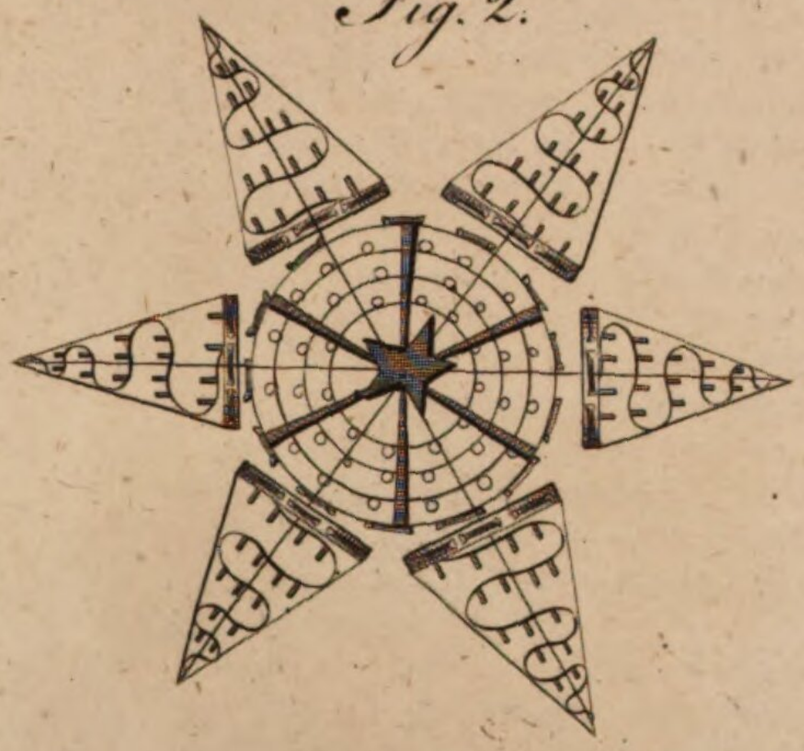


Fig. 3.

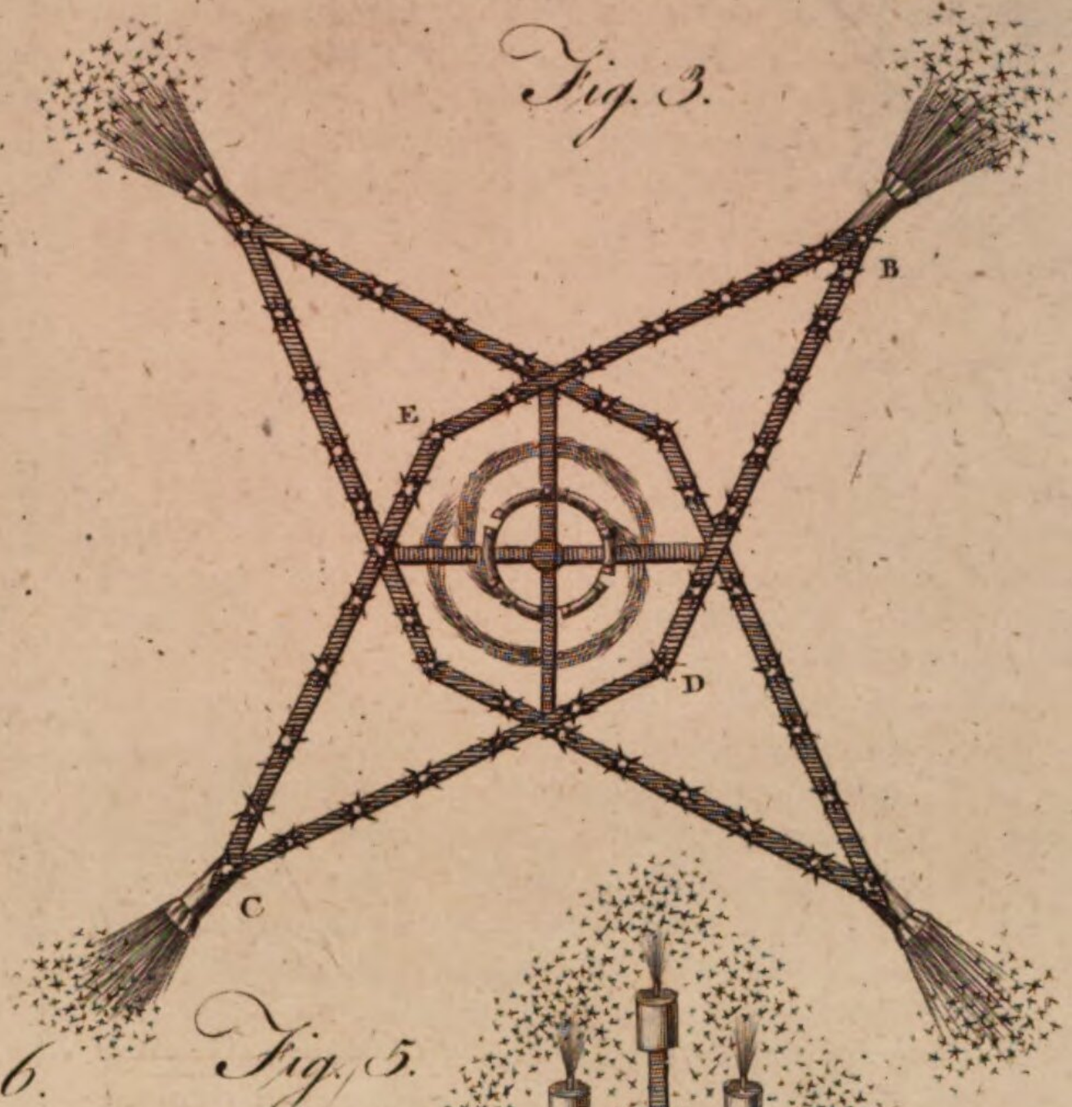
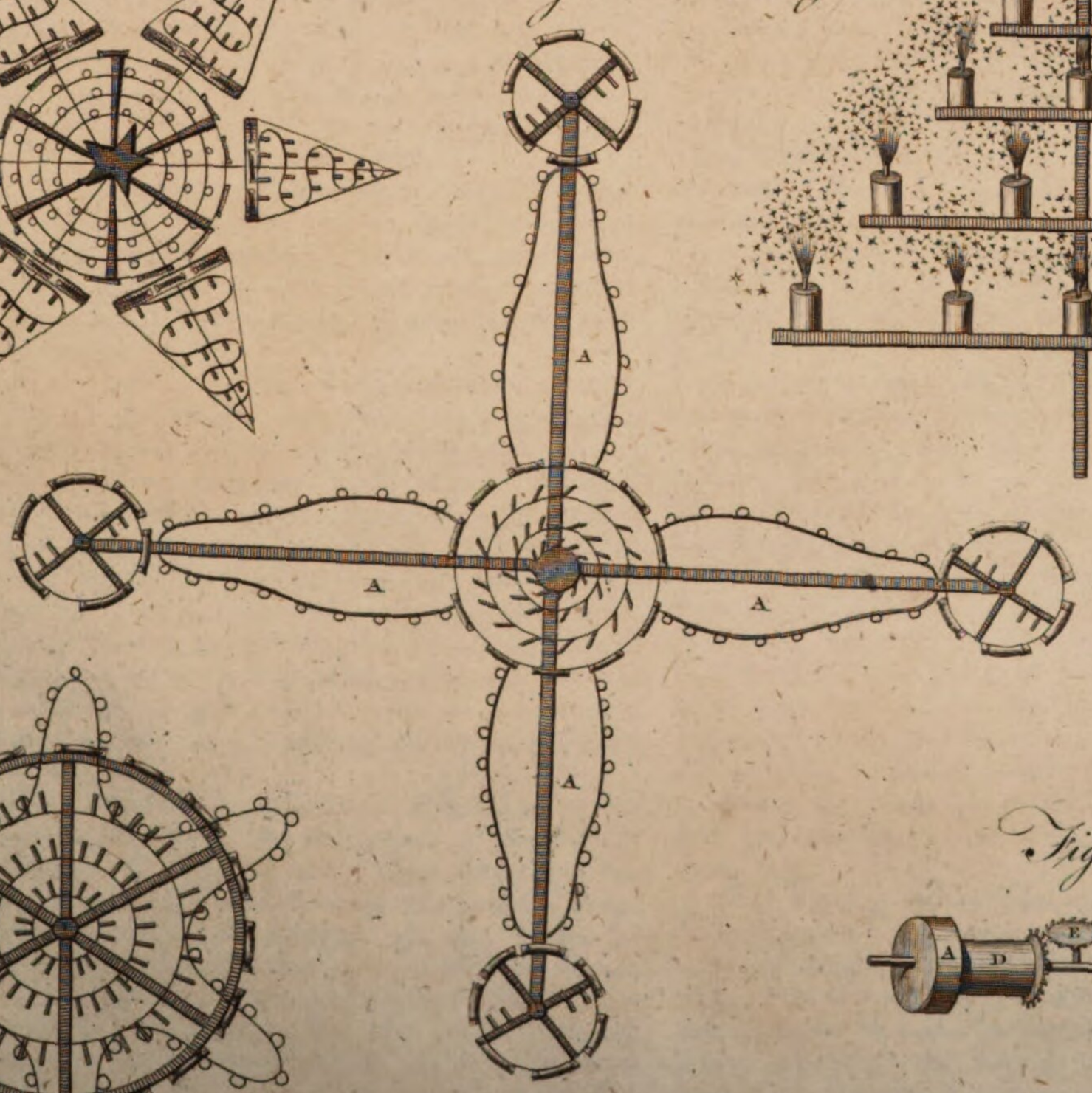


Fig. 6.



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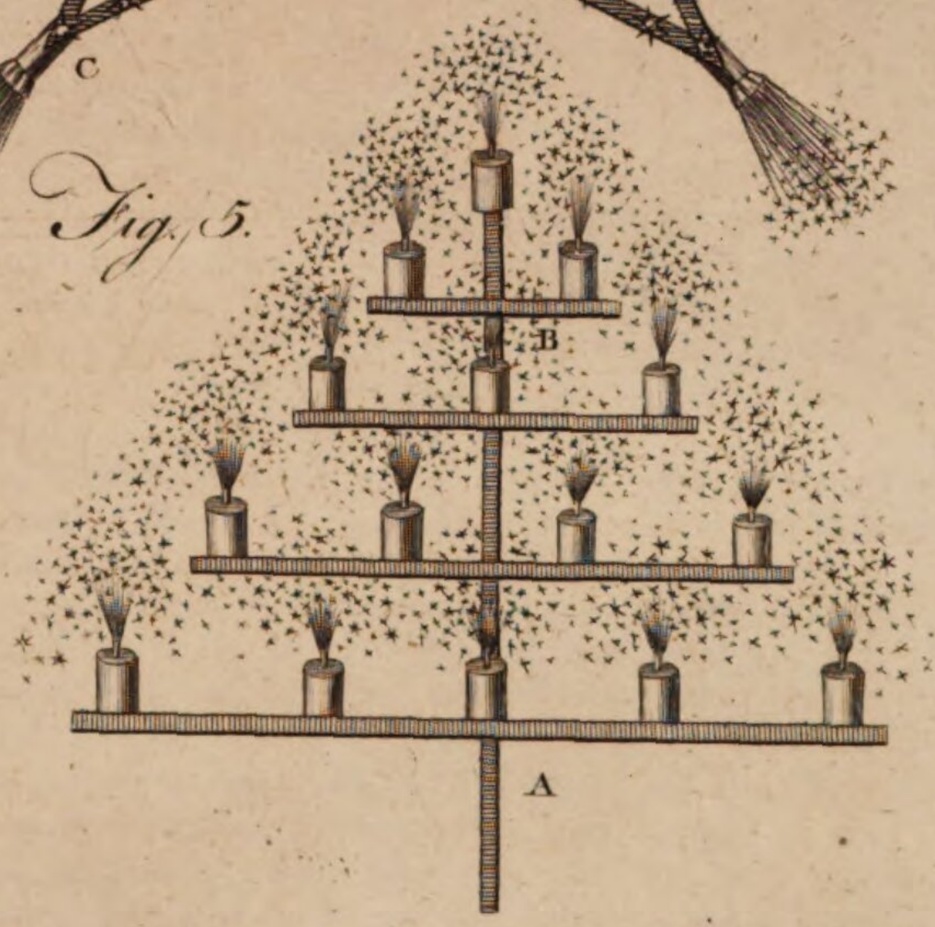

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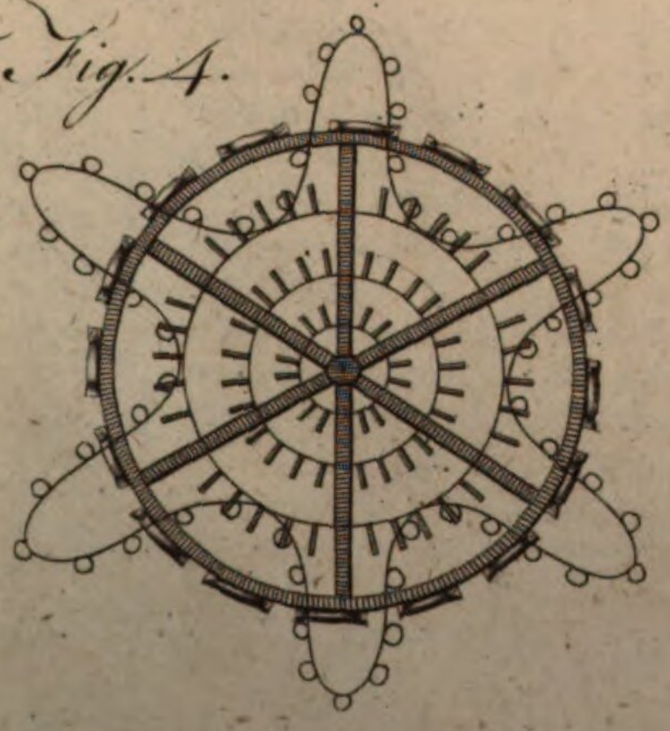
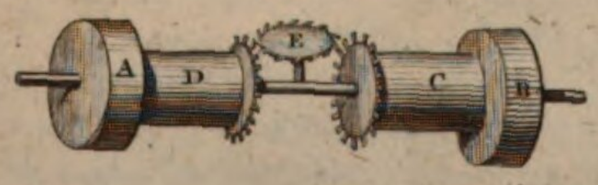


Fig. 7.



A. Bell. Prin. Wal. Sculptor fec.

Pyrus, Pythagoras.

der-making. Thoſe uſed for the deſſert are the following, placed as they ſucceſſively ripen after one another: The white juncating, the margaret apple, the ſummer pearmain, the ſummer queening, the embroidered apple, the golden rennet, the ſummer white calville, the ſummer red calville, the ſilver pippen, the aromatic pippen, *la reinette griſe*, *la haute bonte*, the royal ruſſetting, Wheeler's ruſſet, Sharp's ruſſet, the ſpine apple, the golden pippen, the nonpareil, the *l'api* or *pomme d'api*. Thoſe for the kitchen uſe, in the order of their ripening, are theſe: The codling, the ſummer marygold, the ſummer red pearmain, the Holland pippen, the Kentiſh pippen, the courpendu, Loan's pearmain, the French rennet, the French pippen, the royal ruſſet, the monſtrous rennet, the winter pearmain, the *pome violette*, Spencer's pippen, the ſtone pippen, and the oaken pippen. Thoſe moſt eſteemed for cyder are, the Devonſhire royal wilding, the redſtreak apple, the whitſour, the Herefordſhire under-leaf, and the John apple, or *deux annes*, everlaſting hanger, and gennet moyle.

The juice of apples is a menſtruum for iron. A ſolution of iron in the juice of the apples called *golden rennets*, evaporated to a thick conſiſtence, proves an elegant chalybeate, which keeps well.

The beſt method of preſerving apples for winter uſe, is to let them hang upon the trees until there is danger of froſt, to gather them in dry weather, and then to lay them in large heaps to ſweat for a month or ſix weeks. They ought then to be carefully looked over, all which have the leaſt appearance of decay taken out, the ſound fruit wiped dry, and packed up in large oil jars, which have been thoroughly ſcalded and dry, and then ſtopped cloſe to exclude the air. If this plan is duly obſerved, the fruit will keep a long time ſound, and their fleſh remain plump; whereas, when expoſed to the air, their ſkins will ſhrivel, and their pulp ſoften.

3. The coronaria, or ſweet-ſcented crab of Virginia, grows 12 or 15 feet high, having angular, ſerrated leaves, pedunculated umbels of whitiſh-red, ſweet-ſcented flowers, ſucceeded by ſmall round crabs, remarkably ſour and auſtere. There is one variety, called the *evergreen Virginian crab tree*.

Culture. All the varieties of the pear-tree are hardy, and will ſucceed in any common ſoil of a garden or orchard. They are propagated by grafting and budding upon any kind of pear-ſtocks; alſo occaſionally upon quince-ſtocks, and ſometimes upon white-thorn ſtocks; but pear-ſtocks are greatly preferable to all others for general uſe.—All kinds of apples are propagated in the ſame manner; uſing apple-ſtocks inſtead of pear-ſtocks. They will ſucceed in any common ſoil of a garden or orchard, and in any free ſituation except in a low and very moiſt ſoil, in which they are apt to canker, and very ſoon go off. In a friable loam they are generally very ſucceſsful.

PYTHAGORAS, a celebrated philoſopher of antiquity, reſpecting the time and place of whoſe birth the learned are much divided. Eratoſthenes aſſerts, that in the 48th Olympiad*, when he was very young, he was a victor at the Olympic games. Hence Dr Bentley † determines the date of his birth to be the 4th year of the 43d Olympiad; whilſt Lloyd ‡, who denies that the Olympic victor was the ſame perſon with the philoſopher, places it about the 3d year of the 48th Olympiad. Mr Dodwell § differs from both, and wiſhes to fix the birth of Pythagoras in the 4th year of the 52d Olympiad. Of the arguments of theſe learned writers, Le Clerc has given a ſummary in the *Bibliotheque Choiſée*, tom. x. p. 81. &c. and from a review of the whole, it would appear that he was not born earlier than the 4th year of the 43d Olympiad, nor later than the 4th year of the 52d; but in what particular year of that period his birth took place, cannot with any degree of certainty be aſcertained. It is generally believed that he was born in the iſland of Samos, and that he flouriſhed about 500 years before Chriſt, in the time of Tarquin the laſt king of Rome *. His father Mneſarchus, who is thought by ſome to have been a lapidary, and by others a merchant of Tyre, appears to have been a man of ſome diſtinction, and to have beſtowed upon his ſon the beſt education.

Pythagoras.

Jamblicus † relates a number of wonderful ſtories reſpecting Pythagoras's deſcent from Jupiter, his birth, and early life; and repreſents him even in his youth as a prodigy of wiſdom and manly ſerioufneſs. But moſt of theſe idle tales confute themſelves, afford nothing of importance to be depended upon, and only prove the credulity, careleſſneſs, and prejudice of their author. Of his childhood and early education we know nothing, except that he was firſt inſtructed in his own country by Creophilus, and afterwards in Scyrus by Pherecydes (ſee PHERECYDES). According to the cuſtom of the times he was made acquainted with poetry and muſic; eloquence and aſtronomy became his private ſtudies, and in gymnaſtic exerciſes he often bore the palm for ſtrength and dexterity. He firſt diſtinguiſhed himſelf in Greece at the Olympic games, where, beſide gaining the prize, he is ſaid to have excited the higheſt admiration by the elegance and dignity of his perſon, and the brilliancy of his underſtanding.

Soon after his appearance at theſe games Pythagoras commenced his travels in queſt of knowledge. He firſt viſited Egypt, where, through the intereſt of Polycrates tyrant of Samos, he obtained the patronage of Amaſis king of Egypt, by whoſe influence, combined with his own aſſiduity, patience, and perſeverance, he at length gained the confidence of the prieſts; from whom he learned their ſacred myſteries, theology, and the whole ſyſtem of ſymbolical learning. In Egypt, too, he became acquainted with geometry and the true ſolar ſyſtem; and, before he left that country, made himſelf maſter of all the learning for which it was ſo famed among the nations of antiquity.

He afterwards viſited Perſia and Chaldea, where from the Magi he learnt divination, the interpreting of dreams, and aſtronomy. He is likewiſe ſaid to have travelled into India, to have converſed with the Gymnoſophiſts, and to have acquired from them a knowledge of the philoſophy and literature of the eaſt; and ſuch was his ardour in the purſuit of ſcience, that in queſt of it, we are told by Cicero *, he croſſed many ſeas, and travelled on foot through many barbarous nations.

After Pythagoras had ſpent many years in gathering information on every ſubject, eſpecially reſpecting the nature of the gods, the rites of religion, and the immortality of the human ſoul, he returned to his native iſland, and attempted to make his knowledge uſeful by inſtituting a ſchool for the inſtruction of his countrymen. Failing of ſucceſs in this laudable undertaking, he

* *Tuſc. Queſt.* lib. iv. cap. 1.

† *Vit. Pythag.* n. 6.

* *De Finibus*, lib. iv. § 29.

* An. ante Chr. 588.

† *Diſſert. on the Ep. of Phalaris.*

‡ *Chron. of Pythagoras.*

§ *Two Diſſertations on the age of Phalereus and Pythagoras.*

Pythagoras.

repaired to Delos, where he pretended to receive moral dogmas from the prieſteſs of Apollo. He alſo viſited Crete, where he was initiated into the moſt ſacred myſteries of Greece. He went likewiſe to Sparta and Elis, and again aſſiſted at the Olympic games; where in the public aſſembly he was ſaluted with the title of *ſophiſt* or *wiſe man*, which he declined for one more humble. See PHILOLOGY, n° 1. and PHILOSOPHY n° 1.

He returned to Samos enriched with mythological learning and myſterious rites, and again inſtituted a ſchool. His myſterious ſymbols and oracular precepts made this attempt more ſucceſsful than the former had been; but meeting with ſome oppoſition, or being detected in ſome pious frauds, he ſuddenly left Samos, retired to Magna Grecia, and ſettled at Crotona.

Here he founded the Italic ſect (ſee PHILOSOPHY n° 20.); and his mental and perſonal accompliſhments, the fame of his diſtant travels, and his Olympic crown, ſoon procured him numerous pupils. His bold and manly eloquence and graceful delivery attracted the moſt diſſolute, and produced a remarkable change in the morals of the people of Crotona. His influence was increaſed by the regularity of his own example, and its conformity to his precepts. He punctually attended the temples of the gods, and paid his devotions at an early hour; he lived upon the pureſt and moſt innocent food, clothed himſelf like the prieſts of Egypt, and by his continual purifications and regular offerings appeared to be ſuperior in ſanctity to the reſt of mankind. He endeavoured to aſſuage the paſſions of his ſcholars with verſes and numbers, and made a practice of compoſing his own mind every morning, by playing on his harp, and ſinging along with it the pæans of Thales. To avoid the temptations of eaſe and the ſeductions of idleneſs, bodily exerciſes alſo made a conſiderable part of his diſcipline.

At Crotona he had a public ſchool for the general benefit of the people, in which he taught them their duty, praiſing virtue and condemning vice; and particularly inſtructing them in the duties of ſocial life. Beſide this, he had a college in his own houſe, which he denominated κοινοβιον, in which there were two claſſes of ſtudents, viz. εξωτερικοι, who were alſo called *auſcultantes* and εσωτερικοι. The former of theſe were probationers, and were kept under a long examen. A ſilence of five years was impoſed upon them; which Apuleius thinks was intended to teach them modeſty and attention; but Clemens Alexandrinus thinks it was for the purpoſe of abſtracting their minds from ſenſible objects, and inuring them to the pure contemplation of the Deity. The latter claſs of ſcholars were called *genuini*, *perfecti*, *mathematici*, and, by way of eminence, *Pythagoreans*. They alone were admitted to the knowledge of the arcana and depths of Pythagoric diſcipline, and were taught the uſe of ciphers and hieroglyphic writings.

Clemens obſerves, that theſe orders correſponded very exactly to thoſe among the Hebrews: for in the ſchools of the prophets there were two claſſes, viz. the ſons of the prophets, who were the ſcholars, and the doctors or maſters, who were alſo called *perfecti*; and among the Levites, the novices or tyros, who had their quinquennial exerciſes, by way of preparation. Laſtly, even among the proſelytes there were two orders; *exoterici*, or proſelytes of the gate; and *intrinſeci* or *perfecti*, proſelytes of the covenant. He adds, it is highly probable, that Pythagoras himſelf had been a proſelyte of the gate, if not of the covenant. Gale endeavours to prove that Pythagoras borrowed his philoſophy from that of the Jews; to this end producing the authorities of many of the fathers and ancient authors, and even pointing out the tracks and footſteps of Moſes in ſeveral parts of Pythagoras's doctrine. But we believe the learned author was miſled by the Chriſtian Platoniſts.

The authority of Pythagoras among his pupils was ſo great, that it was even deemed a crime to diſpute his word; and their arguments were conſidered as infallibly convincing, if they could enforce them by adding, that "the maſter ſaid ſo;" an expreſſion which afterwards became proverbial in *jurare in verba magiſtri*. This influence over his ſchool was ſoon extended to the world, and even his pupils themſelves divided the applauſe and approbation of the people with their maſter; and the rulers and legiſlators of all the principal towns of Greece, Sicily, and Italy, boaſted of being the diſciples of Pythagoras. To give more weight to his exhortations, as ſome writers mention, Pythagoras retired into a ſubterraneous cave, where his mother ſent him intelligence of every thing which happened during his abſence. After a certain number of months he again re-appeared on the earth with a grim and ghaſtly countenance, and declared in the aſſembly of the people that he was returned from hell. From ſimilar exaggerations it has been aſſerted that he appeared at the Olympic games with a golden thigh, and that he could write in letters of blood whatever he pleaſed on a looking-glaſs; and that by ſetting it oppoſite to the moon, when full, all the characters which were on the glaſs became legible on the moon's diſc. They alſo relate, that by ſome magical words he tamed a bear, ſtopped the flight of an eagle, and appeared on the ſame day and at the ſame inſtant in the cities of Crotona and Metapontum, &c.

At length his ſingular doctrines, and perhaps his ſtrenuouſly aſſerting the rights of the people againſt their tyrannical governors, excited a ſpirit of jealouſy, and raiſed a powerful party againſt him; which ſoon became ſo outrageous as to oblige him to fly for his life. His friends fled to Rhegium; and he himſelf, after being refuſed protection by the Locrians, fled to Metapontum, where he was obliged to take refuge in the temple of the muſes, and where it is ſaid he died of hunger about 497 years before Chriſt. Reſpecting the time, place, and manner of his death, however, there are various opinions, and many think it uncertain when, where, or in what manner, he ended his days. After his death his followers paid the ſame reſpect to him as was paid to the immortal gods; they erected ſtatues in honour of him, converted his houſe at Crotona into a temple of Ceres, appealed to him as a deity, and ſwore by his name.

Pythagoras married Theano of Crotona, or, according to others, of Crete, by whom he had two ſons, Telauges and Mneſarchus, who, after his death, took care of his ſchool. He is ſaid alſo to have had a daughter called *Damo*.

Whether he left any writings behind him is diſputed. It ſeems probable, however, that he left none, and that ſuch,

Pythagoras.

such as went under his name were written by some of his followers. The *golden verses* which Hierocles illustrated with a commentary, have been ascribed to Epicharmus or Empedocles, and contain a brief summary of his popular doctrines. From this circumstance, and from the mysterious secrecy with which he taught, our information concerning his doctrine and philosophy is very uncertain, and cannot always be depended on.

The purpose of philosophy, according to the system of Pythagoras, is to free the mind from incumbrances, and to raise it to the contemplation of immutable truth and the knowledge of divine and spiritual objects. To bring the mind to this state of perfection is a work of some difficulty, and requires a variety of intermediate steps. Mathematical science was with him the first step to wisdom, because it inures the mind to contemplation, and takes a middle course between corporeal and incorporeal beings. The whole science he divided into two parts, *numbers* and *magnitude;* and each of these he subdivided into two others, the former into *arithmetic* and *music*, and the latter into *magnitude at rest and in motion;* the former of which comprehends *geometry*, and the latter *astronomy*. Arithmetic he considered as the noblest science, and an acquaintance with numbers as the highest good. He considered numbers as the principles of every thing; and divided them into scientific and intelligible. Scientific number is the production of the powers involved in unity, and its return to the same; number is not infinite, but is the source of that infinite divisibility into equal parts which is the property of all bodies. Intelligible numbers are those which existed in the divine mind before all things. They are the model or archetype of the world, and the cause of the essence of beings. Of the Monad, Duad, Triad, Tetrad, and Decad, various explanations have been given by various authors; but nothing certain or important is known of them. In all probability, numbers were used by Pythagoras as symbolical representations of the first principles and forms of nature, and especially of those eternal and immutable essences which Plato denominated ideas; and in this case the Monad was the simple root from which he conceived numbers to proceed, and as such, analogous to the simple essence of deity; from whence, according to his system, the various properties of nature proceed.

Music followed numbers, and was useful in raising the mind above the dominion of the passions. Pythagoras considered it as a science to be reduced to mathematical principles and proportions, and is said to have discovered the musical chords from the circumstance of several men successively striking with hammers a piece of heated iron upon an anvil. This story Dr Burney* discredits; but allows, from the uniform testimony of writers ancient and modern, that he invented the *harmonical canon* or monochord, (see MONOCHORD.) The music of the spheres, of which every one has heard, was a most fanciful doctrine of Pythagoras. It was produced, he imagined, by the planets striking on the ether through which in their motion they passed; and he considered their musical proportions as exact, and their harmony perfect.

* *History of Music*, vol. i. p. 441.

Pythagoras, as we have already seen, learned geometry in Egypt; but by investigating many new theorems, and by digesting its principles, he reduced it to a more regular science. A geometrical point, which he defines to be a monad, or unity with position, he says corresponds to unity in arithmetic, a line to two, a superficies to three, and a solid to four. He discovered several of the propositions of Euclid; and on discovering the 47th of book 1st, he is said to have offered a hecatomb to the gods; but as he was averse to animal sacrifices, this assertion is surely false. His great progress in astronomical science has been mentioned elsewhere. See ASTRONOMY, n° 11, 22; and PHILOSOPHY, n° 15, 16.

Pythagoras.

Wisdom, according to Pythagoras, is conversant with those objects which are naturally immutable, eternal, and incorruptible; and its end is to assimilate the human mind to the divine, and to qualify us to join the assembly of the gods. Active and moral philosophy prescribes rules and precepts for the conduct of life, and leads us to the practice of public and private virtue.—On these heads many of his precepts were excellent, and some of them were whimsical and useless. Theoretical philosophy treats of nature and its origin, and is, according to Pythagoras, the highest object of study. It included all the profound mysteries which he taught, of which but little is now known. God he considers as the universal mind, diffused through all things, and the self-moving principle of all things (αυτοματισμος των παντων), and of whom every human soul is a portion *. It is very probable, that he conceived of the Deity as a subtle fire, eternal, active, and intelligent; which is not inconsistent with the idea of incorporeality, as the ancients understood that term. This Deity was primarily combined with the chaotic mass of passive matter, but he had the power of separating himself, and since the separation he has remained distinct. The learned Cudworth contends, that Pythagoras maintained a trinity of hypostases in the divine nature, similar to the Platonic triad (see PLATONISM). We cannot say that his arguments appear to have much force; but we think the conclusion which he wishes to establish extremely probable, as Plato certainly drew his doctrine from some of the countries which Pythagoras had visited before him.

* *Cicero de Senect.* § 21.

Subordinate to the Deity there were in the Pythagorean creed three orders of intelligences, gods, demons, and heroes, of different degrees of excellence and dignity. These, together with the human soul, were considered as emanations from the Deity, the particles of subtle ether assuming a grosser clothing the farther they receded from the fountain. Hierocles defines a hero to be a rational mind united with a luminous body. God himself was represented under the notion of monad, and the subordinate intelligences as numbers derived from and included in unity. Man is considered as consisting of an elementary nature and a divine or rational soul. His soul, a self-moving principle, is composed of two parts; the rational, seated in the brain; and the irrational, including the passions, in the heart. In both these respects he participates with the brutes, whom the temperament of their body, &c. allows not to act rationally. The sensitive soul perishes; the other assumes an ethereal vehicle, and passes to the regions of the dead, till sent back to the earth to inhabit some other body, brutal or human. See METEMPSYCHOSIS. It was unquestionably this notion which led Pythagoras and his followers to deny themselves the use of flesh, and to be so peculiarly merciful to animals of every description. Some authors, however, say, that flesh and beans, the use of which he also forbad, were prohibited,

Pythagoras.

because he supposed them to have been produced from the same putrified matter, from which, at the creation of the world, man was formed.

Of the symbols of Pythagoras little is known. They have been religiously concealed; and though they have awakened much curiosity, and occasioned many ingenious conjectures, they still appear to us dark and trifling. As a specimen we give the following: "Adore the sound of the whispering wind. Stir not the fire with a sword. Turn aside from an edged tool. Pass not over a balance. Setting out on a journey, turn not back, for the furies will return with you. Breed nothing that hath crooked talons. Receive not a swallow into your house. Look not in a mirror by the light of a candle. At a sacrifice pair not your nails. Eat not the heart or brain. Taste not that which hath fallen from the table. Break not bread. Sleep not at noon. When it thunders touch the earth. Pluck not a crown. Roast not that which has been boiled. Sail not on the ground. Plant not a palm. Breed a cock, but do not sacrifice it, for it is sacred to the sun and moon. Plant mallows in thy garden, but eat them not. Abstain from beans."

The following precepts are more important: "Discourse not of Pythagorean doctrines without light. Above all things govern your tongue. Engrave not the image of God in a ring. Quit not your station without the command of your general. Remember that the paths of virtue and of vice resemble the letter Y. To this symbol Persius refers†, when he says,

† Sat. III. 56.

Et tibi quæ Samios diduxit littera ramos,
Surgentem dextro monstravit limite collem.

There has the Samian Y's instructive make
Pointed the road thy doubtful foot should take;
There warn'd thy raw and yet unpractis'd youth,
To tread the rising right-hand path of truth.

The scantiness and uncertainty of our information respecting Pythagoras, renders a regular and complete account of his life and doctrines impossible. A modern author‡ of profound erudition, pronounces him to have been *unquestionably* the wisest man that ever lived, if his masters the Egyptian priests must not be excepted. This is saying a great deal too much; but that he was one of the most distinguished philosophers of antiquity, or, as Cicero expresses it, *vir præstanti sapientia*, appears very evident; and his moral character has never been impeached. The mysterious air which he threw over his doctrines, and the apparent inanity of some of his symbols, have indeed subjected him to the charge of imposture, and perhaps the charge is not wholly groundless: but when we consider the age in which he lived, and the nature of the people with whom he had to deal, who would in all probability have resisted more open innovations, even this will not appear so blameable as at first sight we are apt to think it; and it is worthy of notice, that the worst stories of this kind have come down to us in a very questionable shape, and with much probability appear to be false.

‡ *Ancient Metaphysics.*

Pythagoreans || Python.

PYTHAGOREANS, a sect of ancient philosophers, so called from being the followers of Pythagoras. See the preceding article.

PYTHIA, the priestess of Apollo at Delphi, by whom he delivered oracles. She was so called from Pythius, a name of that god, which is said to have been given him on account of his victory over the serpent Python.

The Pythia was at first required to be a young girl, but in later times she was a woman of 50 years of age. The first and most famous Pythia was Phemonöe. Oracles were at first delivered by her in hexameter verse. All the pythias were to be pure virgins, and all of them delivered their oracles with great enthusiasm and violent agitations. See ORACLE and DELPHI.

PYTHIAN GAMES, in Grecian antiquity, sports instituted near Delphos in honour of Apollo, on account of his slaying the serpent Python. See APOLLO.—These games, at their first institution, were celebrated only once in nine years; but afterwards every fifth year, from the number of the Parnassian nymphs who came to congratulate Apollo, and to make him presents on his victory. The victor was crowned with garlands.

PYTHON, in fabulous history, a monstrous serpent, produced by the earth after Deucalion's deluge. Juno being exasperated at Latona, who was beloved by Jupiter, commanded this serpent to destroy her; but flying from the pursuit of the monster, she escaped to Delos, where she was delivered of Diana and Apollo; the latter of whom at length destroyed Python with his arrows, in memory of which victory the Pythian games were instituted. See APOLLO.

Q.

Q, or *q*, the 16th letter and 12th consonant of our alphabet; but is not to be found either in the Greek, old Latin, or Saxon alphabets; and indeed some would entirely exclude it, pretending that k ought to be used wherever this occurs. However, as it is formed in the voice in a different manner, it is undoubtedly a distinct letter: for, in expressing this sound, the cheeks are contracted, and the lips, particularly the under one, are put into a canular form, for the passage of the breath.

The q is never sounded alone, but in conjunction with u, as in *quality*, *question*, *quite*, *quote*, &c. and never ends any English word.

As a numeral, Q stands for 500; and with a dash over it, thus $\overline{Q}$, for 500,000.

Used as an abbreviature, *q* signifies *quantity*, or *quantum*.

Quab || Quadrant.

tum. Thus, among phyſicians, *q. pl.* is *quantum placet*, i. e. "as much as you pleaſe" of a thing; and *q. ſ.* is *quantum ſufficit*, i. e. "as much as is neceſſary." Q. E. D. among mathematicians, is *quod erat demonſtrandum*, i. e. "which was to be demonſtrated;" and Q. E. F. is *quod erat faciendum*, i. e. "which was to be done." Q. D. among grammarians, is *quaſi dictum*, i. e. "as if it were ſaid;" or, "as who ſhould ſay." In the notes of the ancients, Q ſtands for *Quintus*, or *Quintius*; Q. B. V. for *quod bene vertat*; Q. S. S. S. for *quæ ſupra ſcripta ſunt*; Q. M. for *Quintus Mutius*, or *quomodo*; Quint. for *Quintilius*; and Quæſ. for *quæſtor*.

QUAB, in ichthyology, the name of a Ruſſian fiſh, which is ſaid to be at firſt a tadpole, then a frog, and at laſt a fiſh. Dr Mounſey, who made many inquiries concerning theſe pretended changes, conſiders them all as fabulous. He had opportunity of ſeeing the fiſh itſelf, and found that they ſpawned like other fiſhes, and grew in ſize, without any appearances to juſtify the report. He adds, that they delight in very clear water, in rivers with ſandy or ſtony bottoms, and are never found in ſtanding lakes, or in rivers paſſing through marſhy or moſſy grounds, where frogs chooſe moſt to be.

QUABES, are a free people of Africa, inhabiting the ſouthern banks of the river Seſtos, and between that and Sierra Leona. They are under the protection of the emperor of Manow.

QUACHA, or QUAGGA. See EQUUS, n° 5.

Marggrave's Hiſt. Braſil.

QUACHILTO, in ornithology, is the name of a very beautiful Braſilian bird, called alſo *yacazintli*, and *porphyrio Americanus*. It is of a fine blackiſh purple colour, variegated with white; its beak is white while young, but becomes red as it grows older, and has a naked ſpace at its baſis, reſembling in ſome ſort the coot; its legs are of a yellowiſh green; it lives about the waters, and feeds on fiſh, yet is a very well taſted bird. It imitates the crowing of a common cock, and makes its muſic early in the morning.

QUACK, among phyſicians, the ſame with empiric. See the article EMPIRIC.

QUADI, (Tacitus); a people of Germany, ſituated to the ſouth-eaſt of the mountains of Bohemia, on the banks of the Danube, and extending as far as the river Marus, or March, running by Moravia, which country they occupied.

QUADRAGESIMA, a denomination given to lent, from its conſiſting of 40 days. See LENT.

QUADRANGLE, in geometry, the ſame with a quadrilateral figure, or one conſiſting of four ſides and four angles.

QUADRANS, the quarter or fourth part of any thing, particularly the *as*, or pound.

QUADRANS, in Engliſh money, the fourth part of a penny. Before the reign of Edward I. the ſmalleſt coin was a *ſterling*, or penny, marked with a croſs; by the guidance of which a penny might be cut into halves for a halfpenny, or into quarters or four parts for farthings; till, to avoid the fraud of unequal cuttings, that king coined halfpence and farthings in diſtinct round pieces.

QUADRANT, in geometry, the arch of a circle, containing 90°, or the fourth part of the entire periphery.

Quadrant.

Sometimes alſo the ſpace or area, included between this arch and two radii drawn from the centre to each extremity thereof, is called a *quadrant*, or, more properly, a *quadrantal ſpace*, as being a quarter of an entire circle.

QUADRANT, alſo denotes a mathematical inſtrument of great uſe in aſtronomy and navigation, for taking the altitudes of the ſun and ſtars, as alſo for taking angles in ſurveying, &c.

This inſtrument is variouſly contrived, and furniſhed with different apparatus, according to the various uſes it is intended for; but they all have this in common, that they conſiſt of a quarter of a circle, whoſe limb is divided into 90°. Some have a plummet ſuſpended from the centre, and are furniſhed with ſights to look through.

The principal and moſt uſeful quadrants are the common ſurveying quadrant, aſtronomical quadrant, Adams's quadrant, Cole's quadrant, Gunter's quadrant, Hadley's quadrant, horodictical quadrant, Sutton's or Collins's quadrant, and the ſinical quadrant, &c. Of each of which in order.

1. The common ſurveying quadrant, is made of braſs, wood, or any other ſolid ſubſtance; the limb of which is divided into 90°, and each of theſe farther divided into as many equal parts as the ſpace will allow, either diagonally or otherwiſe. On one of the ſemidiameters are fitted two moveable ſights; and to the centre is ſometimes alſo fixed a label, or moveable index, bearing two other ſights; but in lieu of theſe laſt ſights there is ſometimes fitted a teleſcope: alſo from the centre there is hung a thread with a plummet; and on the under ſide or face of the inſtrument is fitted a ball and ſocket, by means of which it may be put into any poſition. The general uſe of it is for taking angles in a vertical plane, comprehended under right lines going from the centre of the inſtrument, one of which is horizontal, and the other is directed to ſome viſible point. But beſides the parts already deſcribed, there is frequently added on the face, near the centre, a kind of compartment, called the *quadrat*, or *geometrical ſquare*. See QUADRAT.

This quadrant may be uſed in different ſituations: for obſerving heights or depths, its plane muſt be diſpoſed perpendicularly to the horizon; but to take horizontal diſtances, its plane is diſpoſed parallel thereto. Again, heights and diſtances may be taken two ways, viz. by means of the fixed ſights and plummet, or by the label: As to which, and the manner of meaſuring angles, ſee GEOMETRY, p. 674, &c.

2. The aſtronomical quadrant is a large one, uſually made of braſs, or wooden bars faced with iron plates; having its limb nicely divided, either diagonally or otherwiſe, into degrees, minutes, and ſeconds; and furniſhed with two teleſcopes, one fixed on the ſide of the quadrant, and the other moveable about the centre, by means of the ſcrew. There are alſo dented wheels which ſerve to direct the inſtrument to any object or phenomenon.—The uſe of this curious inſtrument, in taking obſervations of the ſun, planets, and fixed ſtars, is obvious; for being turned horizontally upon its axis, by means of the teleſcope, till the object is ſeen through the moveable teleſcope, then the degrees, &c. cut by the index give the altitude required. See ASTRONOMY, p. 587, &c.

3. Cole's

Quadrant. Plate CCCXXVII.

3. Cole's quadrant is a very uſeful inſtrument invented by Mr Benjamin Cole. It conſiſts of 6 parts, *viz.* the ſtaff AB (fig. 1.); the quadrantal arch DE; three vanes A, B, C; and the vernier FG. The ſtaff is a bar of wood about two feet long, an inch and a quarter broad, and of a ſufficient thickneſs to prevent it from bending or warping. The quadrantal arch is alſo of wood; and is divided into degrees, and third-parts of a degree, to a radius of about nine inches; to its extremities are fitted two radii, which meet in the centre of the quadrant by a pin, round which it eaſily moves. The ſight-vane A is a thin piece of braſs, almoſt two inches in height and one broad, placed perpendicularly on the end of the ſtaff A, by the help of two ſcrews paſſing through its foot. Through the middle of this vane is drilled a ſmall hole, through which the coincidence or meeting of the horizon and ſolar ſpot is to be viewed. The horizon vane B is about an inch broad, and two inches and a half high, having a ſlit cut thro' it of near an inch long and a quarter of an inch broad; this vane is fixed in the centre-pin of the inſtrument, in a perpendicular poſition, by the help of two ſcrews paſſing through its foot, whereby its poſition with reſpect to the ſight-vane is always the ſame, their angles of inclination being equal to 45 degrees. The ſhade-vane C is compoſed of two braſs plates. The one, which ſerves as an arm, is about four inches and a half long, and three quarters of an inch broad, being pinned at one end to the upper limb of the quadrant by a ſcrew, about which it has a ſmall motion; the other end lies in the arch, and the lower edge of the arm is directed to the middle of the centre-pin; the other plate, which is properly the vane, is about two inches long, being fixed perpendicularly to the other plate, at about half an inch diſtance from that end next the arch; this vane may be uſed either by its ſhade or by the ſolar ſpot caſt by a convex lens placed therein. And, becauſe the wood-work is often apt to warp or twiſt, therefore this vane may be rectified by the help of a ſorew, ſo that the warping of the inſtrument may occaſion no error in the obſervation, which is performed in the following manner: Set the line G on the vernier againſt a degree on the upper limb of the quadrant, and turn the ſcrew on the backſide of the limb forward or backward, till the hole in the ſight-vane, the centre of the glaſs, and the ſunk ſpot in the horizon-vane, lie in a right line.

To find the ſun's altitude by this inſtrument: Turn your back to the ſun, holding the inſtrument by the ſtaff with your right hand, ſo that it be in a vertical plane paſſing through the ſun; apply your eye to the ſight-vane, looking through that and the horizon-vane till you ſee the horizon; with the left hand ſlide the quadrantal arch upwards, until the ſolar ſpot or ſhade, caſt by the ſhade-vane, fall directly on the ſpot or ſlit in the horizon-vane; then will that part of the quadrantal arch, which is raiſed above G or S (according as the obſervation reſpected either the ſolar ſpot or ſhade) ſhow the altitude of the ſun at that time. But if the meridian altitude be required, the obſervation muſt be continued; and as the ſun approaches the meridian, the ſea will appear through the horizon-vane, and then is the obſervation finiſhed; and the degrees and minutes, counted as before, will give the ſun's meridian altitude: or the degrees counted from the lower limb upwards will give the zenith-diſtance. Quadrant.

4. Adams's quadrant differs only from Cole's quadrant in having an horizontal vane, with the upper part of the limb lengthened; ſo that the glaſs, which caſts the ſolar ſpot on the horizon-vane, is at the ſame diſtance from the horizon-vane as the ſight-vane at the end of the index.

5. Gunter's quadrant, ſo called from its inventor Edmund Gunter, beſides the uſual apparatus of other quadrants, has a ſtereographical projection of the ſphere on the plane of the equinoctial. It has alſo a kalendar of the months, next to the diviſions of the limb.

Uſe of Gunter's quadrant. 1. To find the ſun's meridian altitude for any given day, or the day of the month for any given meridian altitude. Lay the thread to the day of the month in the ſcale next the limb; and the degree it cuts in the limb is the ſun's meridian altitude. Thus the thread, being laid on the 15th of May, cuts 59° 30', the altitude ſought; and, contrarily, the thread, being ſet to the meridian altitude, ſhows the day of the month. 2. To find the hour of the day. Having put the bead, which ſlides on the thread, to the ſun's place in the ecliptic, obſerve the ſun's altitude by the quadrant; then, if the thread be laid over the ſame in the limb, the bead will fall upon the hour required. Thus ſuppoſe on the 10th of April, the ſun being then in the beginning of Taurus, I obſerve the ſun's altitude by the quadrant to be 36°; I place the bead to the beginning of Taurus in the ecliptic, and lay the thread over 36° of the limb; and find the bead to fall on the hour-line marked 3 and 9; accordingly the hour is either 9 in the morning or 3 in the afternoon. Again, laying the bead on the hour given, having firſt rectified or put it to the ſun's place, the degree cut by the thread on the limb gives the altitude. Note, the bead may be rectified otherwiſe, by bringing the thread to the day of the month, and the bead to the hour-line of 12. 3. To find the ſun's declination from his place given, and contrariwiſe. Set the bead to the ſun's place in the ecliptic, move the thread to the line of declination, and the bead will cut the degree of declination required. Contrarily, the bead being adjuſted to a given declination, and the thread moved to the ecliptic, the bead will cut the ſun's place. 4. The ſun's place being given, to find his right aſcenſion, or contrarily. Lay the thread on the ſun's place in the ecliptic, and the degree it cuts on the limb is the right aſcenſion ſought. Contrarily, laying the thread on the right aſcenſion, it cuts the ſun's place in the ecliptic. 5. The ſun's altitude being given, to find his azimuth, and contrariwiſe. Rectify the bead for the time, as in the ſecond article, and obſerve the ſun's altitude: bring the thread to the complement of that altitude; thus the bead will give the azimuth ſought, among the azimuth lines. 6. To find the hour of the night from ſome of the five ſtars laid down on the quadrant. (1.) Put the bead to the ſtar you would obſerve, and find how many hours it is off the meridian, by artiele 2. (2.) Then, from the right aſcenſion of the ſtar, ſubtract the ſun's right aſcenſion converted into hours, and mark the difference; which difference, added to the obſerved hour of the ſtar from the meri-

Quadrant. dian, ſhows how many hours the ſun is gone from the meridian, which is the hour of the night. Suppoſe on the 15th of May the ſun is in the 4th degree of Gemini, I ſet the bead to Arcturus; and, obſerving his altitude, find him to be in the weſt about 50° high, and the bead to fall on the hour-line of 2 in the afternoon; then will the hour be 11 hours 50 minutes paſt noon, or 10 minutes ſhort of midnight: for 62°, the ſun's right aſcenſion, converted into time, makes 4 hours 8 minutes; which, ſubtracted from 13 hours 58 minutes, the right aſcenſion of Arcturus, the remainder will be 9 hours 50 minutes; which added to 2 hours, the obſerved diſtance of Arcturus from the meridian, ſhows the hour of the night to be 11 hours 50 minutes.

The mural quadrant has already been deſcribed under the article ASTRONOMY, n° 497. It is a moſt important inſtrument, and has of late been much improved by Mr Ramſden, who has diſtinguiſhed himſelf by the accuracy of his diviſions, and by the manner in which he finiſhes the planes by working them in a vertical poſition. He places the plumb-line behind the inſtrument, that there may be no neceſſity for removing it when we take an obſervation near the zenith. His manner of ſuſpending the glaſs, and that of throwing light on the object-glaſs and on the diviſions at the ſame time, are new, and improvements that deſerve to be noticed.—Thoſe of eight feet, which he has made for the obſervatories of Padua and Vilna, have been examined by Dr Maſkelyne; and the greateſt error does not exceed two ſeconds and a half. That of the ſame ſize for the obſervatory of Milan is in a very advanced ſtate. The mural quadrant, of ſix feet, at Blenheim, is a moſt admirable inſtrument. It is fixed to four pillars, which turn on two pivots, ſo that it may be put to the north and to the ſouth in one minute. It was for this inſtrument Mr Ramſden invented a method of rectifying the arc of 90 degrees, on which an able aſtronomer had ſtarted ſome difficulties; but by means of an horizontal line and a plumb-line, forming a kind of croſs, without touching the circle, he ſhowed him that there was not an error of a ſingle ſecond in the 90 degrees; and that the difference was occaſioned by a mural quadrant of Bird, in which the arc of 90 degrees was too great by ſeveral ſeconds, and which had never been rectified by ſo nice a method as that of Mr Ramſden.

But the quadrant is not the inſtrument which ſtands higheſt in Mr Ramſden's opinion; it is the complete circle: and he has demonſtrated to M. de la Lande, that the former muſt be laid aſide, if we would arrive at the utmoſt exactneſs of which an obſervation is capable. His principle reaſons are: 1. The leaſt variation in the centre is perceived by the two diametrically oppoſite points. 2. The circle being worked on the turn, the ſurface is always of the greateſt accuracy, which it is impoſſible to obtain in the quadrant. 3. We may always have two meaſures of the ſame arc, which will ſerve for the verification of each other. 4. The firſt point of the diviſion may be verified every day with the utmoſt facility. 5. The dilatation of the metal is uniform, and cannot produce any error. 6. This inſtrument is a meridian glaſs at the ſame time. 7. It alſo becomes a moveable azimuth circle by adding an horizontal circle beneath its axis, and then gives the refractions independent of the menſuration of time. Quadrant.

6. Hadley's quadrant is an inſtrument of vaſt utility both in navigation and practical aſtronomy. It derives its name from Mr Hadley, who firſt publiſhed an account of it, though the firſt thought originated with the celebrated Dr Hooke, and was completed by Sir Iſaac Newton (ſee ASTRONOMY, n° 32. and alſo n° 17. and 22.) The utility of this quadrant ariſes from the accuracy and preciſion with which it enables us to determine the latitude and longitude; and to it is navigation much indebted for the very great and rapid advances it has made of late years. It is eaſy to manage, and of extenſive uſe, requiring no peculiar ſteadineſs of hand, nor any ſuch fixed baſis as is neceſſary to other aſtronomical inſtruments. It is uſed as an inſtrument for taking angles in maritime ſurveying, and with equal facility at the maſt head as upon the deck, by which its ſphere of obſervation is much extended; for ſuppoſing many iſlands to be viſible from the maſt head, and only one from deck, no uſeful obſervation can be made by any other inſtrument. But by this, angles may be taken at the maſt head from the one viſible object with great exactneſs; and further, taking angles from heights, as hills, or a ſhip maſt's head, is almoſt the only way of exactly deſcribing the figure and extent of ſhoals.

It has been objected to the uſe of this inſtrument for ſurveying, that it does not meaſure the horizontal angles, by which alone a plan can be laid down. This objection, however true in theory, may be reduced in practice by a little caution; and Mr Adams has given very good directions for doing ſo.

Notwithſtanding, however, the manifeſt ſuperiority of this inſtrument over thoſe that were in uſe at the time of its publication, it was many years before the ſailors could be perſuaded to adopt it, and lay aſide their imperfect and inaccurate inſtruments; ſo great is the difficulty to remove prejudice, and emancipate the mind from the ſlavery of opinion. No inſtrument has undergone, ſince the original invention, more changes than the quadrant of Hadley; of the various alterations, many had no better foundation than the caprice of the makers, who by theſe attempts have often rendered the inſtrument more complicated in conſtruction, and more difficult in uſe, than it was in its original ſtate.

It is an eſſential property of this inſtrument, derived from the laws of reflection, that half degrees on the arch anſwer to whole ones in the angles meaſured: hence an octant, or the eighth part of a circle, or 45 degrees on the arch, ſerves to meaſure 90 degrees; and ſextants will meaſure an angular diſtance of 120 degrees, tho' the arch of the inſtrument is no more than 60 degrees. It is from this property that foreigners term that inſtrument an *octant*, which we uſually call a *quadrant*, and which in effect it is. This property reduces indeed conſiderably the bulk of the inſtrument: but at the ſame time it calls for the utmoſt accuracy in the diviſions, as every error on the arch is doubled in the obſervation.

Another eſſential, and indeed an invaluable, property of this inſtrument, whereby it is rendered peculiarly advantageous in marine obſervations, is, that it is not liable

Quadrant. to be disturbed by the ship's motion; for provided the mariner can see distinctly the two objects in the field of his instrument, no motion nor vacillation of the ship will injure his observation.

Thirdly, the errors to which it is liable are easily discovered and readily rectified, while the application and use of it is facile and plain.

To find whether the two surfaces of any one of the reflecting glasses be parallel, apply your eye at one end of it, and observe the image of some object reflected very obliquely from it; if that image appears single, and well-defined about the edges, it is a proof that the surfaces are parallel: on the contrary, if the edge of the reflected images appear misted, as if it threw a shadow from it, or separated like two edges, it is a proof that the two surfaces of the glass are inclined to each other: if the image in the speculum, particularly if that image be the sun, be viewed through a small telescope, the examination will be more perfect.

To find whether the surface of a reflecting glass be plane. Choose two distant objects, nearly on a level with each other; hold the instrument in an horizontal position, view the left hand object directly through the transparent part of the horizon-glass, and move the index till the reflected image of the other is seen below it in the silvered part; make the two images unite just at the line of separation, then turn the instrument round slowly on its own plane, so as to make the united images move along the line of separation of the horizon-glass. If the images continue united without receding from each other, or varying their respective position, the reflecting surface is a good plane.

To find if the two surfaces of a red or darkening glass are parallel and perfectly plane. This must be done by means of the sun when it is near the meridian, in the following manner: hold the sextant vertically, and direct the sight to some object in the horizon, or between you and the sky, under the sun; turn down the red glass and move the index till the reflected image of the sun is in contact with the object seen directly: fix then the index, and turn the red glass round in its square frame; view the sun's image and object immediately, and if the sun's image is neither raised nor depressed, but continues in contact with the object below, as before, then the surfaces of the darkening glass are true.

For a more particular description of Hadley's quadrant, and the mode of using it, see NAVIGATION, Book II. Chap. I.

This instrument has undergone several improvements since its first invention, and among these improvers must be ranked Mr Ramsden. He found that the essential parts of the quadrant had not a sufficient degree of solidity; the friction at the centre was too great, and in general the alidada might be moved several minutes without any change in the position of the mirror; the divisions were commonly very inaccurate, and Mr Ramsden found that Abbé de la Caille did not exceed the truth in estimating at five minutes the error to which an observer was liable in taking the distance between the moon and a star; an error capable of producing a mistake of 50 leagues in the longitude. On this account Mr Ramsden changed the principle of construction of the centre, and made the instrument in such a Quadrant. manner as never to give an error of more than half a minute; and he has now brought them to such a degree of perfection as to warrant it not more than six seconds in a quadrant of fifteen inches. Since the time of having improved them, Mr Ramsden has constructed an immense number; and in several which have been carried to the East Indies and America, the deficiency has been found no greater at their return than it had been determined by examinations before their being taken out. Mr Ramsden has made them from 15 inches to an inch and a half, in the latter of which the minutes are easily distinguishable; but he prefers for general use those of 10 inches, as being more easily handled than the greater, and at the same time capable of equal accuracy. See SEXTANT.

A great improvement was also made in the construction of this quadrant by Mr Peter Dollond, famous for his invention of achromatic telescopes. The glasses of the quadrants should be perfect planes, and have their surfaces perfectly parallel to one another. By a practice of several years, Mr Dollond found out methods of grinding them of this form to great exactness; but the advantage which should have arisen from the goodness of the glasses was often defeated by the index-glass being bent by the frame which contains it. To prevent this, Mr Dollond contrived the frame so that the glass lies on three points, and the part that presses on the front of the glass has also three points opposite to the former. These points are made to confine the glass by three screws at the back, acting directly oppofite to the points between which the glass is placed. The principal improvements, however, are in the methods of adjusting the glasses, particularly for the back-observation. The method formerly practised for adjusting that part of the instrument by means of the opposite horizons at sea, was attended with so many difficulties that it was scarce ever used: for so little dependence could be placed on the observations taken this way, that the best Hadley's sextants made for the purpose of observing the distances of the moon from the sun or fixed stars have been always made without the horizon-glass for the back-observation; for want of which, many valuable observations of the sun and moon have been lost, when their distance exceeded 120 degrees. To make the adjustment of the back-observation easy and exact, he applied an index to the back horizon-glass, by which it may be moved in a parallel position to the index-glass, in order to give it the two adjustments in the same manner as the fore-horizon-glass is adjusted. Then, by moving the index to which the back-horizon-glass is fixed exactly 90 degrees (which is known by the divisions made for that purpose), the glass will thereby be set at right angles to the index-glass, and will be properly adjusted for use; and the observations may be made with the same accuracy by this as by the fore-observation. To adjust the horizon-glasses in the perpendicular position to the plane of the instrument, he contrived to move each of them by a single screw, which goes through the frame of the quadrant, and is turned by means of a milled head at the back; which may be done by the observer while he is looking at the object. To these improvements also he

Quadrant. he added a method invented by Mr Maſkelyne, of placing darkening-glaſſes behind the horizon-glaſſes. Theſe, which ſerve for darkening the object ſeen by direct viſion, in adjuſting the inſtrument by the ſun or moon, he placed in ſuch a manner as to be turned behind the fore horizon-glaſs, or behind the back horizon-glaſs: there are three of theſe glaſſes of different degrees of darkneſs.

We have been the more particular in our deſcription and uſe of Hadley's quadrant, as it is undoubtedly the beſt hitherto invented.

7. Horodictical quadrant, a pretty commodious inſtrument, ſo called from its uſe in telling the hour of the day.—Its conſtruction is this: From the centre of Plate CCCCXXVII. the quadrant, C, fig. 3. whoſe limb AB is divided into 90°, deſcribe ſeven concentric circles at intervals at pleaſure; and to theſe add the ſigns of the zodiac, in the order repreſented in the figure. Then applying a ruler to the centre C and the limb AB, mark upon the ſeveral parallels the degrees correſponding to the altitude of the ſun when therein, for the given hours; connect the points belonging to the ſame hour with a curve line, to which add the number of the hour. To the radius CA fit a couple of ſights, and to the centre of the quadrant C tie a thread with a plummet, and upon the thread a bead to ſlide. If now the thread be brought to the parallel wherein the ſun is, and the quadrant directed to the ſun, till a viſual ray paſs through the ſights, the bead will ſhow the hour; for the plummet, in this ſituation, cuts all the parallels in the degrees correſponding to the ſun's altitude. Since the bead is in the parallel which the ſun deſcribes, and through the degrees of altitude to which the ſun is elevated every hour there paſs hour-lines, the bead muſt ſhow the preſent hour. Some repreſent the hour-lines by arches of circles, or even by ſtraight lines, and that without any ſenſible error.

8. Sutton's or Collins's quadrant (fig. 4.) is a ſtereographic projection of one quarter of the ſphere between the tropics, upon the plane of the ecliptic, the eye being in its north-pole: it is fitted to the latitude of London. The lines running from the right hand to the left are parallels of altitude; and thoſe croſſing them are azimuths. The leſſer of the two circles, bounding the projection, is one fourth of the tropic of Capricorn; the greater is one fourth of that of Cancer. The two ecliptics are drawn from a point on the left edge of the quadrant, with the characters of the ſigns upon them; and the two horizons are drawn from the ſame point. The limb is divided both into degrees and time; and, by having the ſun's altitude, the hour of the day may be found here to a minute. The quadrantal arches next the centre contain the kalendar of months; and under them, in another arch, is the ſun's declination. On the projection are placed ſeveral of the moſt noted fixed ſtars between the tropics; and the next below the projection is the quadrant and line of ſhadows.—To find the time of the ſun's riſing or ſetting, his amplitude, his azimuth, hour of the day, &c. by this quadrant: lay the thread over the day and the month, and bring the bead to the proper ecliptic, either of ſummer or winter, according to the ſeaſon, which is called *rectifying*; then, moving the thread, bring the bead to the horizon, in which caſe the thread will cut the limb in the time of the ſun's riſing or ſetting before or after ſix; and at the ſame time the bead will cut the horizon in the degrees of the ſun's amplitude.—Again, obſerving the ſun's altitude with the quadrant, and ſuppoſing it found 45° on the fifth of May, lay the thread over the fifth of May, bring the bead to the ſummer ecliptic, and carry it to the parallel of altitude 45°; in which caſe the thread will cut the limb at 55° 15′, and the hour will be ſeen among the hour-lines to be either 41′ paſt nine in the morning, or 19′ paſt two in the afternoon.—Laſtly, the bead among the azimuths ſhows the ſun's diſtance from the ſouth 50° 41′. But note, that if the ſun's altitude be leſs than what it is at ſix o'clock, the operation muſt be performed among thoſe parallels above the upper horizon; the bead being rectified to the winter ecliptic. Quadrant.

9. Sinical quadrant (fig. 5.) conſiſts of ſeveral concentric quadrantal arches, divided into eight equal parts by radii, with parallel right lines croſſing each other at right angles. Now any one of the arches, as BC, may repreſent a quadrant of any great circle of the ſphere, but is chiefly uſed for the horizon or meridian. If then BC be taken for a quadrant of the horizon, either of the ſides, as AB, may repreſent the meridian; and the other ſide, AC, will repreſent a parallel, or line of eaſt and weſt: and all the other lines, parallel to AB, will be alſo meridians; and all thoſe parallel to AC, eaſt and weſt lines, or parallels.—Again, the eight ſpaces into which the arches are divided by the radii, repreſent the eight points of the compaſs in a quarter of the horizon; each containing 11° 15′. The arch BC is likewiſe divided into 90°, and each degree ſubdivided into 12′, diagonal-wiſe. To the centre is fixed a thread, which, being laid over any degree of the quadrant, ſerves to divide the horizon.

If the ſinical quadrant be taken for a fourth part of the meridian, one ſide thereof, AB, may be taken for the common radius of the meridian and equator; and then the other, AC, will be half the axis of the world. The degrees of the circumference, BC, will repreſent degrees of latitude; and the parallels to the ſide AB, aſſumed from every point of latitude to the axis AC, will be radii of the parallels of latitude, as likewiſe the ſine complement of thoſe latitudes.

Suppoſe, then, it be required to find the degees of longitude contained in 83 of the leſſer leagues in the parallel of 48°; lay the thread over 48° of latitude on the circumference, and count thence the 83 leagues on AB, beginning at A; this will terminate in H, allowing every ſmall interval four leagues. Then tracing out the parallel HE, from the point H to the thread; the part AE of the thread ſhows that 125 greater or equinoctial leagues make 6° 15′; and therefore that the 83 leſſer leagues AH, which make the difference of longitude of the courſe, and are equal to the radius of the parallel HE, make 6° 15′ of the ſaid parallel.

If the ſhip ſails an oblique courſe, ſuch courſe, beſides the north and ſouth greater leagues, gives leſſer leagues eaſterly and weſterly, to be reduced to degrees of longitude of the equator. But theſe leagues being made neither on the parallel of departure, nor on that of arrival, but in all the intermediate ones, we muſt find a mean proportional parallel between them. To find this, we have on the inſtrument a ſcale of croſs latitudes. Suppoſe then it were required to find a

Quadrant || Quadrat.

mean parallel between the parallels of 40° and 60°; with your compaſſes take the middle between the 40th and 60th degree on this ſcale: the middle point will terminate againſt the 51ſt degree, which is the mean parallel required.

The principal uſe of the ſinical quadrant is to form triangles upon, ſimilar to thoſe made by a ſhip's way with the meridians and parallels; the ſides of which triangles are meaſured by the equal intervals between the concentric quadrants and the lines N and S, E and W: and every fifth line and arch is made deeper than the reſt. Now, ſuppoſe a ſhip to have ſailed 150 leagues north-eaſt, one fourth north, which is the third point, and makes an angle of 33° 44′ with the north part of the meridian: here are given the courſe and diſtance ſailed, by which a triangle may be formed on the inſtrument ſimilar to that made by the ſhip's courſe; and hence the unknown parts of the triangle may be found. Thus, ſuppoſing the centre A to repreſent the place of departure; count, by means of the concentric circles along the point the ſhip ſailed on, viz. AD, 150 leagues: then in the triangle AED, ſimilar to that of the ſhip's courſe, find AE = difference of latitude, and DE = difference of longitude, which muſt be reduced according to the parallel of latitude come to.

10. Gunner's quadrant (fig. 6.), ſometimes called *gunner's ſquare*, is that uſed for elevating and pointing cannon, mortars, &c. and conſiſts of two branches either of braſs or wood, between which is a quadrantal arch divided into 90 degrees, beginning from the ſhorter branch, and furniſhed with a thread and plummet, as repreſented in the figure.——The uſe of the gunner's quadrant is extremely eaſy; for if the longeſt branch be placed in the mouth of the piece, and it be elevated till the plummet cut the degree neceſſary to hit a propoſed object, the thing is done. Sometimes on one of the ſurfaces of the long branch are noted the diviſion of diameters and weights of iron bullets, as alſo the bores of pieces.

Quadrant of Altitude, is an appendage of the artificial globe, conſiſting of a lamina, or ſlip of braſs, the length of a quadrant of one of the great circles of the globe, and graduated. At the end, where the diviſion terminates, is a nut rivetted on, and furniſhed with a ſcrew, by means whereof the inſtrument is fitted on the meridian, and moveable round upon the rivet to all points of the horizon.——Its uſe is to ſerve as a ſcale in meaſuring of altitudes, amplitudes, azimuths, &c. See ASTRONOMY, n° 379, &c.

QUADRANTAL, in antiquity, the name of a veſſel in uſe among the Romans for the meaſuring of liquids. It was at firſt called *amphora*; and afterwards *quadrantal*, from its form, which was ſquare every way like a die. Its capacity was 80 libræ, or pounds of water, which made 48 ſextaries, two urnæ, or eight congii.

QUADRAT, a mathematical inſtrument, called alſo a *Geometrical Square*, and *Line of Shadows*: it is frequently an additional member on the face of the common quadrant, as alſo on thoſe of Gunter's and Sutton's quadrants. See GEOMETRY, p. 672. and Plate CCXVII. fig. 1—5.

QUADRAT, in printing, a piece of metal uſed to fill up the void ſpaces between words, &c. There are quadrats of different ſizes; as m-quadrats, n-quadrats, &c. which are reſpectively of the dimenſions of theſe letters, only lower, that they may not receive the ink.

Quadratic || Quadriga.

QUADRATIC EQUATIONS, in algebra, thoſe wherein the unknown quantity is of two dimenſions, or raiſed to the ſecond power. See ALGEBRA.

QUADRATRIX, in geometry, a mechanical line, by means whereof we can find right lines equal to the circumference of circles, or other curves, and their ſeveral parts.

QUADRATURE, in geometry, denotes the ſquaring, or reducing a figure to a ſquare. Thus, the finding of a ſquare, which ſhall contain juſt as much ſurface or area as a circle, an ellipſis, a triangle, &c. is the quadrature of a circle, ellipſis, &c. The quadrature, eſpecially among the ancient mathematicians, was a great poſtulatum. The quadrature of rectilineal figures is eaſily found, for it is merely the finding their areas or ſurfaces *i. e.* their ſquares; for the ſquares of equal areas are eaſily found by only extracting the roots of the areas thus found. See GEOMETRY, Part II. chap. 3. The quadrature of curvilinear ſpaces is of more difficult inveſtigation; and in this reſpect extremely little was done by the ancients, except the finding the quadrature of the parabola by Archimedes. In 1657, Sir Paul Neil, Lord Brouncker, and Sir Chriſtopher Wren, geometrically demonſtrated the equality of ſome curvilinear ſpaces to rectilinear ſpaces; and ſoon after the like was proved both at home and abroad of other curves, and it was afterwards brought under an analytical calculus; the firſt ſpecimen of which was given to the public in 1688 by Mercator, in a demonſtration of Lord Brouncker's quadrature of the hyperbola, by Dr Wallis's reduction of a fraction into an infinite ſeries by diviſion. Sir Iſaac Newton, however, had before diſcovered a method of attaining the quantity of all quadruple curves analytically by his fluxions before 1668. It is diſputed between Sir Chriſtopher Wren and Mr Huygens which of them firſt diſcovered the quadrature of any determinate cycloidal ſpace. Mr Leibnitz afterwards found that of another ſpace; and in 1669, Bernoulli diſcovered the quadrature of an infinity of cycloidal ſpaces both ſegments and ſectors, &c. See GEOMETRY, Part II. chap. 3. prop. 33.; and FLUXIONS, p. 314.

QUADRATURE, in aſtronomy, that aſpect of the moon when ſhe is 90° diſtant from the ſun; or when ſhe is in a middle point of her orbit, between the points of conjunction and oppoſition, namely, in the firſt and third quarters. See ASTRONOMY, n° 320, &c.

QUADRATUS, in anatomy, a name given to ſeveral muſcles on account of their ſquare figure. See ANATOMY, *Table of the Muſcles*.

QUADREL, in building, a kind of artificial ſtone, ſo called from its being perfectly ſquare. The quadrels are made of a chalky earth, &c. and dried in the ſhade for two years. Theſe were formerly in great requeſt among the Italian architects.

QUADRIGA, in antiquity, a car or chariot drawn by four horſes. On the reverſes of medals, we frequently ſee the emperor or Victory in a quadriga, holding the reins of the horſes; whence theſe coins are, among the curious, called *nummi quadrigati*, and *victoriati*.

Quadrilateral, Quadrille.

QUADRILATERAL, in geometry, a figure whoſe perimeter conſiſts of four ſides and four angles; whence it is alſo called a *quadrangular figure*.

QUADRILLE, a little troop or company of cavaliers, pompouſly dreſſed, and mounted for the performance of carouſals, juſts, tournaments, runnings at the ring, and other gallant divertiſements.

QUADRILLE, a game played by four perſons, with 40 cards; which are the remains of a pack, after the four tens, nines, and eights are diſcarded; theſe are dealt three and three, and one round four, to the right hand player; and the trump is made by him that plays with or without calling, by naming ſpades, clubs, diamonds, or hearts, and the ſuit named is trumps. If the perſon who names the trump ſhould miſtake, and ſay ſpades inſtead of clubs, or if he name two ſuits, the firſt named is the trump.

In this game the order of the cards, according to their natural value, is as follows: of hearts and diamonds, *king, queen, knave, ace, deuce, three, four, five, ſix, ſeven;* in all 10; of ſpades and clubs, *king, queen, knave, ſeven, ſix, five, four, three, deuce;* in all 9. The reaſon why the ace of ſpades and ace of clubs are not mentioned, is, becauſe they are always trumps, in whatever ſuit that is played. The ace of ſpades being always the firſt, and the ace of clubs the third trump, for the cards ranked according to their value when *trumps* ſtand in the following order.

Hearts and diamonds SPADILL, or the *ace of ſpades*; MANILL, the *ſeventh* of the two *red ſuits*; BASTO, the *ace of clubs*; PONTO, the *ace of hearts* and *diamonds*; *king, queen, knave, deuce, three, four, five, ſix*; in all 12. Spades and clubs, SPADILL the ace of ſpades, MANILL the *deuce* of ſpades and clubs, BASTO the ace of clubs; *king, queen, knave, ſeven, ſix, five, four, three*; in all 11. It is here to be obſerved, that the card which is *manill* and the ſecond trump, is always the loweſt in its ſuit when not trumps; and that the ace of hearts or diamonds, which when trump is above the king, is below the knave when not trump.

There are three matadores; ſpadill, manill, and baſto; the privilege of which is, that when the player has no other trumps but them, and trumps are led, he is not obliged to play them, but may play what card he thinks proper, provided, however, that the trump led is of an inferior rank; but if ſpadill ſhould be led, he that has manill or baſto only, is obliged to play it; it is the ſame of manill baſto, with reſpect to the ſuperior matadore always forcing the inferior. Though there are properly but three matadores, nevertheleſs, all thoſe trumps which follow the three firſt without interruption, are likewiſe called matadores; but the three firſt only enjoy the privilege above mentioned.

Each perſon is to play as he judges moſt convenient for his own game. He is not to encourage his friend to play; but each perſon ought to know what to do when it is his turn to play. The ſtakes conſiſt of ſeven equal mils or *contrats*, as they are ſometimes called, compriſing the ten counters and fiſhes, which are given to each player. A mil is equal to ten fiſh, and each fiſh to ten counters: the value of the fiſh is according to the players agreement, as alſo the number of tours, which are generally fixed at ten, and marked by turning the corners of a card. Quadrille.

If the cards ſhould happen not to be dealt right, or that there ſhould be two cards of the ſame ſort, as two deuces of ſpades, for example, there muſt be a new deal; provided it is diſcovered before the cards are all played. The cards muſt likewiſe be dealt over again in caſe a card is turned in dealing, as it might be of prejudice to him who ſhould have it; and of courſe if there ſhould be ſeveral cards turned. There is no penalty for dealing wrong, he who does ſo muſt only deal again.

When each player has got his ten cards, he that is on the right hand of the dealer, after examining his game, and finding his hand fit to play, aſks if they play; or if he has not a good hand, he paſſes, and ſo the ſecond, third, and fourth. All the four may paſs; but he that has ſpadill, after having ſhown or named it, is obliged to play by calling a king. Whether the deal is played in this manner, or that one of the players has aſked leave, nobody chooſing to play without calling, the eldeſt hand muſt begin the play, firſt naming his ſuit, and the king which he calls; he who wins the trick plays another card, and ſo of the reſt till the game is finiſhed. The tricks then are counted; and if the ombre, that is, he who ſtands the game, has, together with him who is the king called, ſix tricks, they have won and are paid the game, the conſolation, and the matadores, if they have them, and divide what is upon the game, and the beaſts if there are any. But if they make only five tricks, it is a remiſe, and they are beaſted, what goes upon the game, paying to the other players the conſolation and the matadores. If the tricks are equally divided betwixt them, they are likewiſe beaſted; and if they make only four tricks between them, it is a remiſe; if they make leſs they loſe codill (A), and in that caſe they pay to their adverſaries what they ſhould have received if they had won; that is, the game, the conſolation, and the matadores, if they have them, and are beaſted what is upon the game: they who win codill, divide the ſtakes. The beaſt, and every thing elſe that is paid, is paid equally betwixt the two loſers; one half by him that calls, and the other half by him that is called, as well in caſe of codill as a remiſe; unleſs the ombre does not make three tricks, in which caſe he that is called is not only exempted from paying half the beaſt, but alſo the game, the conſolation, and the matadores if there are any, which the ombre in that caſe pays alone; and as well in caſe of a codill as a remiſe. This is done in order to oblige players not to play games that are unreaſonable. There is, nevertheleſs, one caſe in which if the ombre makes only one trick, he is not beaſted alone, and that is, when not having a good hand he paſſes, and all the other players have paſſed likewiſe; he having ſpadill is obliged to play. Here it would be unjuſt to oblige him to make three or four tricks; in this caſe, therefore, he that is

(A) Codill is when thoſe who defend the pool make more tricks than they who ſtand the game; which is called *winning the codill*.

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called pays one half of the loſings. For which reaſon he that has ſpadill with a bad hand, ſhould paſs, that if he is afterwards obliged to play by calling a king (which is called *forced ſpadill*), he may not be beaſted alone. He that has once paſſed cannot be admitted to play; and he that has aſked leave cannot refuſe to play, unleſs any one ſhould offer to play without calling.

He that has four kings, may call a queen to one of his kings, except that which is trump. He that wants one or more kings, may call one of thoſe kings; but in that caſe, he muſt make ſix tricks alone, and conſequently he wins or loſes alone. The king of that ſuit in which he plays cannot be called. No one ſhould play out of his turn, although he is not beaſted for ſo doing. If he who is not the eldeſt hand has the king called, and plays ſpadill, manill, or baſto, or even the king called in order to ſhow that he is the friend, having other kings that he fears the ombre ſhould trump, he is not to be allowed to go for the vole; he is even beaſted, if it appears to be done with that intent. It is not permitted to ſhow a hand though codill may already be won; that it may be ſeen whether the ombre is beaſted alone. If the ombre or his friend ſhows their cards before they have made ſix tricks, thinking that they have made them, and there appears a poſſibility of preventing their making them, the other players can oblige them to play their cards as they think proper.

A player need only name his ſuit when he plays, without calling a king. He who plays without calling muſt make ſix tricks alone to win; for all the other players are united againſt him, and they are to do what they can to prevent his winning. He who plays without calling, is admitted to play in preference to him who would play with calling; however, if he that has aſked leave will play without calling, he has the preference of the other who would force him. Theſe are the two methods of play without calling that are called forced.

As he who plays without calling does not divide the winnings with any perſon, he conſequently, when he loſes, pays all by himſelf; if he loſes by remiſe he is beaſted, and pays each of the other players the conſolation, the *ſans appeller* (which is commonly, but improperly, called the *ſans prendre*), and the matadores if there are any; if he loſes codill he is likewiſe beaſted, and pays to each player what he would have received from each if he had win. They who win codill divide what there is; and if there are any counters remaining, they belong to him of the three who ſhall have ſpadill or the higheſt trump the next deal. It is the ſame with regard to him who calls one of his own kings, he wins alone or loſes alone as in the other caſe, except the ſans appeller, which he does not pay if he loſes, or receive if he wins, although he plays alone.

If he plays ſans appeller, though he may have a ſure game, he is obliged to name his ſuit; which if he neglects to do, and ſhows his cards, and ſays "I play ſans appeller;" in that caſe either of the other players can oblige him to play in what ſuit he pleaſes, although he ſhould not have one trump in that ſuit.

He who has aſked leave is not permitted to play ſans appeller, unleſs he is forced; in which caſe, as was ſaid before, he has the preference of the other that forces him. Quadrille.

A player is not obliged to trump when he has none of the ſuit led, nor play a higher card in that ſuit if he has it, being at his option although he is the laſt player, and the trick ſhould belong to the ombre; but he is obliged to play in the ſuit led if he can, otherwiſe he renounces. If he ſeparates a card from his game and ſhows it, he is obliged to play it, if by not doing it the game may be prejudiced, or if it can give any intelligence to his friend; but eſpecially if it ſhould be a matadore.—He that plays ſans appeller, or by calling himſelf, is not ſubject to this law. He may turn the tricks made by the other players, and count what has been played as often as it is his turn to play, but not otherwiſe. If inſtead of turning a player's tricks, he turns and ſees his game, or ſhows it to the other players, he is beaſted, together with him whoſe cards he turned; and each of them muſt pay one half of the beaſt.

If any one renounces, he is beaſted as often as he has renounced and it is detected; but a renounce is not made till the trick is turned. If the renounce is diſcoverd before the deal is finiſhed, and has been detrimental to the game, the cards muſt be taken up again, and the game replayed from that trick where the renounce was made; but if the cards are all played, the beaſt is ſtill made, and the cards muſt not be replayed; except there ſhould be ſeveral renounces in the ſame deal: then they are to be played again, unleſs the cards ſhould be mixed. If ſeveral beaſts are made in the ſame deal, they all go together, unleſs it is otherwiſe agreed at the beginning of the party; and when there are ſeveral beaſts, the greateſt always goes firſt.

A great advantage accrues from being eldeſt hand at quadrille, which often renders it very diſagreeable to the reſt of the players, being obliged to paſs with a good hand unleſs they chooſe to play alone; and when it happens that the eldeſt hand having aſked leave, the ſecond player has three matadores, ſeveral trumps in back, and all ſmall cards, he cannot then even play alone; and having no chance of being called, he muſt paſs with this good hand. On account of which, this method has been thought expedient to remedy this defect of the game; each player having an opportunity of availing himſelf of the goodneſs of his game, by adding to the uſual method of playing the game that of the mediateur, and the favourite ſuit.

The firſt thing to be obſerved is that of drawing for places, which is done in this manner: One of the players takes four cards; a king, a queen, a knave, and an ace; each player draws one of theſe cards; and commonly he who comes in laſt, draws firſt. The perſon who draws the king ſits where he pleaſes, the queen at his right hand, the knave next the queen, and the ace on the left of the king. The king draws the favourite ſuit. The number of cards and perſons is the ſame at this game as the other, and is played in the ſame manner.

The favourite ſuit is determined by drawing a card out of the pack, and is of the ſame ſuit, during the whole party, of the card ſo drawn.

A king is the mediateur, which is demanded of the others by one of the players, who has a hand he expects

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pects to make five tricks of; and through the aſſiſtance of this king he can play alone and make ſix tricks.

In return for the king received, he gives what card he thinks proper with a fiſh; but muſt give two fiſh if it is in the favourite ſuit. He who aſks by calling in the favourite ſuit, has the preference to him who aſks by calling in any other; he who aſks with the mediateur, has the preference to him who aſks by calling in the favourite ſuit, and by playing alone is obliged to make ſix tricks to win. He who aſks with the mediateur in the favourite ſuit, has the preference to him who aſks with the mediateur in any other ſuit, and is obliged to play alone, and to make ſix tricks.

If ſans prendre is played in any other ſuit than the favourite, he who plays it has the preference to him who aſks only, or with the mediateur, or even he who plays in the favourite ſuit with the mediateur; and the ſans prendre in the favourite ſuit has the preference to all other players whatever.

The only difference between this method of playing the game and the other is, that when one of the players demands the mediateur he is obliged to play alone, and to make ſix tricks, as if he played ſans prendre. In this caſe he ſhould judge from the ſtrength of his hand, whether the aid of the king will enable him to play alone or not.

With the mediateur and without the favourite ſuit it is played in this manner. The game is marked and played the ſame as in common, except that a fiſh extraordinary is given to him who plays the mediateur, and to him who plays ſans prendre; that is, he who wins the mediateur receives 13 counters from each; and if he loſes by remiſe he pays 12 to each; and 13 if by codill. The winner of ſans prendre receives 17 counters from each; and if by remiſe he loſes, he pays 16 to each, and 17 if by codill.

The vole with the mediateur receives one fiſh only, as at common quadrille. The beaſts are alſo the ſame as the common game. The laſt game is generally played double, and is called *paulans*; but for thoſe who chooſe to play a higher game, they may play the double colour, which is called the *Turk*, and is double of the favourite ſuit. There is alſo a higher game than this called the *auóde*, which is paying whatever is agreed to him who happens to hold the two aces in his hand.

We have omitted many things reſpecting the mode of marking the game, and playing the vole, becauſe theſe are different in different caſes, and are to be learned only by practice. The game itſelf is a very inferior one; but he who wiſhes to know more of it, may conſult Hoyle's games improved by James Beaufort, Eſq; from which we have, with very little alteration, taken this article.

QUADRUPEDS, in zoology; thoſe animals which have four limbs or legs proceeding from the trunk of their body. See ZOOLOGY; in which article notice will be taken of the method of preſerving ſpecimens of theſe and other animals.

QUÆSTOR, ſee QUESTOR.

QUAGGA, or QUACHA. See EQUUS, n° 5.

QUAIL, in zoology. See TETRAO.

Quails are to be taken by means of the call during their whole wooing time, which laſts from April to Auguſt. The proper times for uſing the call are at ſun-riſing, at nine o'clock in the morning, at three in the afternoon, and at ſun-ſet; for theſe are the natural times of the quail's calling. The notes of the cock and hen quail are very different; and the ſportſman who expects to ſucceed in the taking them muſt be expert in both: for when the cock calls, the anſwer is to be made in the hen's note; and when the hen calls, the anſwer is to be made in the cock's. By this means they will come up to the perſon, ſo that he may, with great eaſe, throw the net over them and take them. If a cock-quail be ſingle, on hearing the hen's note he will immediately come; but if he have a hen already with him, he will not forſake her. Sometimes, though only one quail anſwers to the call, there will three or four come up; and then it is beſt to have patience, and not run to take up the firſt, but ſtay till they are all entangled, as they will ſoon be.

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The quail is a neat cleanly bird, and will not run much into dirty or wet places: in dewy mornings, they will often fly inſtead of running to the call; and in this caſe, it is beſt to let them go over the net, if it ſo happens that they fly higher than its top; and the ſportſman then changing ſides, and calling again, the bird will come back, and then will probably be taken in the net.

The calls are to be made of a ſmall leather purſe, about two fingers wide, and four fingers long, and made in the ſhape of a pear; this is to be ſtuffed half-full of horſe-hair, and at the end of it is to be placed a ſmall whiſtle, made of the bone of a rabbit's leg, or ſome other ſuch bone: this is to be about two inches long, and the end formed like a flageolet, with a little ſoft wax. This is to be the end faſtened into the purſe; the other is to be cloſed up with the ſame wax, only that a hole is to be opened with a pin, to make it give a diſtinct and clear ſound. To make this ſound, it is to be held full in the palm of the hand, with one of the fingers placed over the top of the wax; then the purſe is to be preſſed, and the finger is to ſhake over the middle of it, to modulate the ſound it gives into a ſort of ſhake. This is the moſt uſeful call; for it imitates the note of the hen-quail, and ſeldom fails to bring a cock to the net if there be one near the place.

The call that imitates the note of the cock, and is uſed to bring the hen to him, is to be about four inches long, and above an inch thick; it is to be made of a piece of wire turned round and curled, and covered with leather; and one end of it muſt be cloſed up with a piece of flat wood, about the middle of which there muſt be a ſmall thread or ſtrap of leather, and at the other end is to be placed the ſame ſort of pipe, made of bone, as is uſed in the other call. The noiſe is made by opening and cloſing the ſpiral, and gives the ſame ſound that the cock does when he gives the hen a ſignal that he is near her.

QUAKERS, a religious ſociety, which took its riſe in England about the middle of the laſt century, and rapidly found its way into other countries in Europe, and into the Engliſh ſettlements in North America.—The members of this ſociety, we believe, called themſelves at firſt *ſeekers*, from their *ſeeking* the truth; but after the ſociety was formed, they aſſumed the appellation of *friends*. The name of *quakers* was given to them by their enemies; and though an epithet of reproach, ſeems to be ſtamped upon them indelibly. Their founder

Quakers.

der is generally believed to have been George Fox, an illiterate ſhoemaker (ſee *George Fox*), but this opinion has been lately controverted. An ingenious writer ‡ having found, or fancied, a ſimilarity of ſentiments among the ancient Druids and modern Quakers, ſeems to think that Fox muſt have been nothing more than a tool employed by certain deiſts to pave the way for their ſyſtem of natural religion, by allegorizing the diſtinguiſhing articles of the Chriſtian faith.

‡ See *Month. Rev.* Sept. 1793, art. 5.

It muſt be confeſſed, for experience will not allow it to be denied, that extremes in religion are very apt to beget each other; and if the deiſts alluded to reaſoned from this fact, they could not have pitched upon a tool fitter for their purpoſe than George Fox. From his works ſtill extant, he appears to have been one of the moſt extravagant and abſurd enthuſiaſts that ever lived, and to have fancied himſelf, in his apoſtolic character, ſomething infinitely ſuperior to man. In a book called *News coming out of the North* (p. 15.) he ſays of himſelf, "I am the Door that ever was, the ſame Chriſt yeſterday, to-day, and for ever:" And in the introduction to his *Battle-door for Teachers and Profeſſors*, he ſays, "All languages are to me no more than duſt, who was before languages were." But one of the moſt extraordinary and blaſphemous things that he ever wrote, is an anſwer to the Protector, who had required him to promiſe not to diſturb his government as then eſtabliſhed. It is as follows:

"I who am of the world called G: F doth deny the carrying or drawing any carnal ſword againſt any, or againſt thee O: C: or any man, in the preſence of the Lord I declare it, God is my witneſs, by whom I am moved to give this forth for the truth's ſake, from him whom the world calls G: Fox, *who is the ſon of God*, who is ſent to ſtand a witneſs againſt all violence and againſt the works of darkneſs, and to turn the people from darkneſs to light, and to bring them from the occaſion of the war and from the occaſion of the magiſtrates ſword, which is a terror to the evil doer, which acts contrary to the light of the Lord *Jeſus Chriſt*; which is a praiſe to them that do well; which is a protection to them that do well, and not the evil; and ſuch ſoldiers as are put in place no falſe accuſers muſt be, no violence muſt do, but be content with their wages: and that magiſtrate bears not the ſword in vain, from under the occaſion of that ſword do I ſeek to bring people: my weapons are not carnal but ſpiritual, and *my kingdom is not of this world*; therefore with carnal weapon I do not fight, but am from thoſe things dead, from him who is not of this world, called of the world by the name of G: F: and this I am ready to ſeal with my blood; this I am moved to give forth for the truth's ſake, who a witneſs ſtands againſt all unrighteouſneſs, and all ungodlineſs, who a ſufferer is for the righteous ſeed's ſake, waiting for the redemption of it, who a crown that is mortal ſeeks not, for that fadeth away; but in the light dwells which comprehends that crown, which light is the condemnation of all ſuch, in which light I witneſs the crown that is immortal, which fades not away from him who to all your ſouls is a friend, for eſtabliſhing of righteouſneſs, and clearing the land of evil doers, and a witneſs againſt all the wicked inventions of man, and murderer's plots, which anſwer ſhall be with the light in all your conſciences, which makes no covenant with death; to which light in you all I ſpeak, and am clear, G: F: who a new name hath, which the world knows not." (A).

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The Quakers, however, did not long entruſt the defence of their principles to ſuch ſenſeleſs enthuſiaſts as George Fox: They were joined by a number of learned, ingenious, and pious men, who new-modelled their creed; and though they did not bring it to what is generally deemed the Chriſtian ſtandard, they ſo reformed it as that its tenets do not ſhock common ſenſe, nor the duties preſcribed ſcandalize a man of piety. The chief of theſe reformers were George Keith, the celebrated Penn, and our countryman Barclay. Keith was indeed excommunicated for the liberties which he took with the great apoſtle; but we have not a doubt but his writings contributed to the moderation of Penn, and to the elegant and maſterly apology of Barclay. From that apology we ſelected the ſummary of their opinions which was given in the former edition of this work; but they have lately publiſhed ſuch a ſummary themſelves, of which the reader will be pleaſed with the following abſtract:

They tell us, that about the beginning of the 17th century, a number of men, diſſatisfied with all the *modes* of religious worſhip then known in the world, withdrew from the communion of every viſible church to ſeek the Lord in retirement. Among theſe was their *honourable elder George Fox*, who being quickened by the immediate touches of divine love, could not ſatisfy his apprehenſions of duty to God without directing the people where to find the like conſolation and inſtruction. In the courſe of his travels, he met with many ſeeking perſons in circumſtances ſimilar to his own, and theſe readily received his teſtimony. They then give us a ſhort account of their ſufferings and different ſettlements; and with a degree of candour which does them infinite credit, they vindicate Charles II. from the character of a perſecutor; acknowledging, that though they ſuffered much during his reign, he gave as little countenance as he could to the ſeverities of the legiſlature. They even tell us, that he exerted his influence to reſcue their friends from the unprovoked and cruel perſecutions of the New England fanatics; and they ſpeak with becoming gratitude of the different acts paſſed in their favour during the reigns of William and Mary, and George I. They then proceed to give us the following account of their doctrine:

"We

(A) We have tranſcribed this letter from the theological works of Mr Leſlie, where it is preſerved in its original form. The Quakers, after the death of their apoſtle, expunged from their edition of it the words which we have printed in Italics; aſhamed, as we hope, of the blaſphemy imputed to them: but that Mr Leſlie's copy is authentic, is thus atteſted by two of the friends, who ſaw Fox deliver it to the protector's meſſenger: "We are witneſſes of this teſtimony, whoſe names in the fleſh are, *Tho. Aldam.* *Rob. Craven*

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"We agree with other profeſſors of the Chriſtian name, in the belief in one eternal God, the Creator and Preſerver of the univerſe; and in Jeſus Chriſt his Son, the Meſſiah, and Mediator of the new covenant (Heb. xii. 24).

"When we ſpeak of the gracious diſplay of the love of God to mankind, in the miraculous conception, birth, life, miracles, death, reſurrection, and aſcenſion of our Saviour, we prefer the uſe of ſuch terms as we find in Scripture; and, contented with that knowledge which divine wiſdom hath ſeen meet to reveal, we attempt not to explain thoſe myſteries which remain under the veil; nevertheleſs, we acknowledge and aſſert the divinity of Chriſt, who is the wiſdom and power of God unto ſalvation (1 Cor. i. 24).

"To Chriſt alone we give the title of the Word of God (John i. 1.) and not to the Scriptures; although we highly eſteem theſe ſacred writings, in ſubordination to the Spirit (2 Pet. i. 21.), from which they were given forth; and we hold, with the apoſtle Paul, that they are able to make wiſe unto ſalvation, through faith which is in Chriſt Jeſus (2 Tim. iii. 15).

"We reverence thoſe moſt excellent precepts which are recorded in Scripture to have been delivered by our great Lord, and we firmly believe that they are practicable, and binding on every Chriſtian; and that in the life to come every man will be rewarded according to his works (Mat. xvi. 27). And farther, it is our belief, that, in order to enable mankind to put in practice theſe ſacred precepts, many of which are contradictory to the unregenerate will of man (John i. 9.), every man coming into the world is endued with a meaſure of the light, grace, or good Spirit of Chriſt; by which, as it is attended to, he is enabled to diſtinguiſh good from evil, and to correct the diſorderly paſſions and corrupt propenſities of his nature, which mere reaſon is altogether inſufficient to overcome. For all that belongs to man is fallible, within the reach of temptation; but this divine grace, which comes by Him who hath overcome the world (John xvi. 33.) is, to thoſe who humbly and ſincerely ſeek it, an all-ſufficient and preſent help in time of need. By this the ſnares of the enemy are detected, his allurements avoided, and deliverance is experienced through faith in its effectual operation; whereby the ſoul is tranſlated out of the kingdom of darkneſs, and from under the power of Satan, into the marvellous light and kingdom of the Son of God.

"Being thus perſuaded that man, without the Spirit of Chriſt inwardly revealed, can do nothing to the glory of God, or to effect his own ſalvation; we think this influence eſpecially neceſſary to the performance of the higheſt act of which the human mind is capable, even the worſhip of the Father of lights and of ſpirits, in ſpirit and in truth; therefore we conſider as obſtructions to pure worſhip, all forms which divert the attention of the mind from the ſecret influence of this unction from the Holy One (1 John ii. 20, 27). Yet, although true worſhip is not confined to time and place, we think it incumbent on Chriſtians to meet often together (Heb. x. 25.) in teſtimony of their dependence on the heavenly Father, and for a renewal of their ſpiritual ſtrength: nevertheleſs, in the performance of worſhip, we dare not depend, for our acceptance with Him, on a formal repetition of the words and experiences of others; but we believe it to be our duty to ceaſe from the activity of the imagination, and to wait in ſilence to have a true ſight of our condition beſtowed upon us: believing even a ſingle ſigh (Rom. viii. 26.) ariſing from ſuch a ſenſe of our infirmities, and of the need we have of divine help, to be more acceptable to God, than any performances, however ſpecious, which originate in the will of man.

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"From what has been ſaid reſpecting worſhip, it follows, that the miniſtry we approve muſt have its origin from the ſame ſource: for that which is needful for a man's own direction, and for his acceptance with God (Jer. xxiii. 30, to 32.) muſt be eminently ſo to enable him to be helpful to others. Accordingly, we believe the renewed aſſiſtance of the light and power of Chriſt to be indiſpenſably neceſſary for all true miniſtry; and that this holy influence is not at our command, or to be procured by ſtudy, but is the free gift of God to his choſen and devoted ſervants.—From hence ariſes our teſtimony againſt preaching for hire, and in contradiction to Chriſt's poſitive command, "Freely ye have received, freely give;" (Mat. x. 8.) and hence our conſcientious refuſal to ſupport ſuch miniſtry by tithes or other means.

"As we dare not encourage any miniſtry but that which we believe to ſpring from the influence of the Holy Spirit, ſo neither dare we attempt to reſtrain this influence to perſons of any condition in life, or to the male ſex alone; but, as male and female are one in Chriſt, we allow ſuch of the female ſex as we believe to be endued with a right qualification for the miniſtry, to exerciſe their gifts for the general edification of the church: and this liberty we eſteem to be a peculiar mark of the goſpel diſpenſation, as foretold by the prophet Joel (Joel ii. 28, 29.) and noticed by the apoſtle Peter (Acts ii. 16, 17).

"There are two ceremonies in uſe amongſt moſt profeſſors of the Chriſtian name; Water-baptiſm, and what is termed the Lord's Supper. The firſt of theſe is generally eſteemed the eſſential means of initiation into the church of Chriſt; and the latter of maintaining communion with him. But as we have been convinced, that nothing ſhort of his redeeming power, inwardly revealed, can ſet the ſoul free from the thraldom of ſin, by this power alone we believe ſalvation to be effected. We hold that as there is one Lord and one faith (Eph. iv. 5.), ſo his baptiſm is one in nature and operation; that nothing ſhort of it can make us living members of his myſtical body; and that the baptiſm with water, adminiſtered by his fore-runner John, belonged, as the latter confeſſed, to an inferior and decreaſing diſpenſation (John iii. 30).

"With reſpect to the other rite, we believe that communion between Chriſt and his church is not maintained by that nor any other external performance, but only by a real participation of his divine nature (2 Pet. i. 4.) through faith; that this is the ſupper alluded to in the Revelation (Rev. iii. 20.), "Behold I ſtand at the door and knock, if any man hear my voice, and open the door, I will come in to him, and will ſup with him, and he with me;" and that where the ſubſtance is attained, it is unneceſſary to attend to the ſhadow, which doth not confer grace, and concerning which opinions ſo different, and animoſities ſo violent, have ariſen.

"Now, as we thus believe that the grace of God, which comes by Jeſus Chriſt, is alone ſufficient for ſalvation,

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"There are not many of our tenets more generally known than our teſtimony againſt oaths and againſt war. With reſpect to the former of theſe, we abide literally by Chriſt's poſitive injunction, delivered in his ſermon on the mount, "Swear not at all" (Mat. v. 34)*. From the ſame ſacred collection of the moſt excellent precepts of moral and religious duty, from the example of our Lord himſelf (Mat. ch. v. 39, 44, &c. ch. xxvi. 52, 53.; Luke xxii. 51.; John xviii. 11.), and from the correſpondent convictions of his Spirit in our hearts, we are confirmed in the belief that wars and fightings are, in their origin and effects, utterly repugnant to the Goſpel, which ſtill breathes peace and good-will to men. We alſo are clearly of the judgment, that if the benevolence of the Goſpel were generally prevalent in the minds of men, it would effectually prevent them from oppreſſing, much more from enſlaving, their brethren, (of whatever colour or complexion), for whom, as for themſelves, Chriſt died; and would even influence their conduct in their treatment of the brute creation, which would no longer groan the victims of their avarice, and of their falſe ideas of pleaſure.

* See *Oath.*

"Some of our tenets have in former times, as hath been ſhown, ſubjected our friends to much ſuffering from government, though to the ſalutary purpoſes of government our principles are a ſecurity. They inculcate ſubmiſſion to the laws in all caſes wherein conſcience is not violated. But we hold, that as Chriſt's kingdom is not of this world, it is not the buſineſs of the civil magiſtrate to interfere in matters of religion; but to maintain the external peace and good order of the community. We therefore think perſecution, even in the ſmalleſt degree, unwarrantable. We are careful in requiring our members not to be concerned in illicit trade, nor in any manner to defraud the revenue.

"It is well known that the ſociety, from its firſt appearance, has diſuſed thoſe names of the months and days which, having been given in honour of the heroes or falſe gods of the heathens, originated in their flattery or ſuperſtition; and the cuſtom of ſpeaking to a ſingle perſon in the plural number (B), as having ariſen alſo from motives of adulation. Compliments, ſuperfluity of apparel and furniture, outward ſhows of rejoicing and mourning, and obſervation of days and times, we eſteem to be incompatible with the ſimplicity and ſincerity of a Chriſtian life; and public diverſions, gaming, and other vain amuſements of the world, we cannot but condemn. They are a waſte of that time which is given us for nobler purpoſes, and divert the attention of the mind from the ſober duties of life, and from the reproofs of inſtruction, by which we are guided to an everlaſting inheritance. Quakers.

"To conclude, although we have exhibited the ſeveral tenets which diſtinguiſh our religious ſociety, as objects of our belief, yet we are ſenſible that a true and living faith is not produced in the mind of man by his own effort; but is the free gift of God (Eph. ii. 8.) in Chriſt Jeſus, nouriſhed and increaſed by the progreſſive operation of his ſpirit in our hearts, and our proportionate obedience (John vii. 17.). Therefore, although, for the preſervation of the teſtimonies given us to bear, and for the peace and good order of the ſociety, we deem it neceſſary that thoſe who are admitted into membership with us, ſhould be previouſly convinced of thoſe doctrines which we eſteem eſſential; yet we require no formal ſubſcription to any articles, either as the condition of membership, or to qualify for the ſervice of the church. We prefer the judging of men by their fruits, in a dependence on the aid of Him who, by his prophet, hath promiſed to be "a ſpirit of judgment to him that ſitteth in judgment" (Iſaiah xxviii. 6). Without this, there is a danger of reciving numbers into outward communion, without any addition to that ſpiritual ſheepfold, whereof our bleſſed Lord declared himſelf to be both the door and the ſhepherd (John x. 7, 11.) that is, ſuch as know his voice, and follow him in the paths of obedience."

Such are the doctrines of this people as we find them ſtated in a ſmall pamphlet lately preſented by themſelves to the public; and in the ſame tract they give the following account of their diſcipline.

"In the practice of diſcipline, we think it indiſpenſable that the order recommended by Chriſt himſelf be invariably obſerved: (Matth. xviii. 15. to 17.) 'If thy brother ſhall treſpaſs againſt thee, go and tell him his fault between thee and him alone: if he ſhall hear thee, thou haſt gained thy brother; but if he will not hear thee, then take with thee one or two more, that in the mouth of two or three witneſſes every word may be eſtabliſhed; and if he ſhall neglect to hear them, tell it unto the church.'

"To effect the ſalutary purpoſes of diſcipline, meetings were appointed, at an early period of the ſociety, which, from the times of their being held, were called quarterly-meetings. It was afterwards found expedient to divide the diſtricts of thoſe meetings, and to meet more often; whence aroſe monthly-meetings, ſubordinate to thoſe held quarterly. At length, in 1669, a yearly-meeting was eſtabliſhed, to ſuperintend, aſſiſt, and provide, rules for the whole; previous to which, general meetings had been occaſionally held.

"A monthly-meeting is uſually compoſed of ſeveral particular congregations, ſituated within a convenient diſtance of each other. Its buſineſs is to provide for the ſubſiſtence of their poor, and for the education of of their offſpring; to judge of the ſincerity and fitneſs of perſons appearing to be convinced of the religious principles of the ſociety, and deſiring to be admitted

(B) Speaking of this cuſtom, Fox ſays: "When the Lord ſent me into the world, he forbad me to put off my hat to any; and I was required to *thee* and *thou* all men and women." *Journal*, p. 24.

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into membership; to excite due attention to the discharge of religious and moral duty; and to deal with disorderly members. Monthly-meetings also grant to such of their members as remove into other monthly-meetings, certificates of their membership and conduct; without which they cannot gain membership in such meetings. Each monthly-meeting is required to appoint certain persons under the name of *overseers*, who are to take care that the rules of our discipline be put in practice; and when any case of complaint or disorderly conduct comes to their knowledge, to see that private admonition, agreeable to the gospel rule beforementioned, be given previously to its being laid before the monthly-meeting.

"When a case is introduced, it is usual for a small committee to be appointed to visit the offender, to endeavour to convince him of his error, and to induce him to forsake and condemn it. If they succeed, the person is by minute declared to have made satisfaction for the offence; if not, he is disowned as a member of the society.

"In disputes between individuals, it has long been the decided judgment of the society that its members should not sue each other at law. It therefore enjoins all to end their differences by speedy and impartial arbitration, agreeable to rules laid down. If any refuse to adopt this mode, or, having adopted it, to submit to the award, it is the direction of the yearly-meeting that such be disowned.

"To monthly-meetings also belongs the allowing of marriages; for our society hath always scrupled to acknowledge the exclusive authority of the priests in the solemnization of marriage. Those who intend to marry, appear together and propose their intention to the monthly-meeting; and if not attended by their parents or guardians, produce a written certificate of their consent, signed in the presence of witnesses. The meeting then appoints a committee to inquire whether they are clear of other engagements respecting marriage; and if at a subsequent meeting, to which the parties also come and declare the continuance of their intention, no objections are reported, they have the meeting's consent to solemnize their intended marriage. This is done in a public meeting for worship; towards the close whereof the parties stand up, and solemnly take each other for husband and wife. A certificate of the proceedings is then publicly read, and signed by the parties, and afterwards by the relations and others as witnesses. Of such certificates the monthly-meeting keeps a record; as also of the births and burials of its members. A certificate of the date, of the name of the infant, and of its parents, signed by those present at the birth, is the subject of one of these last-mentioned records; and an order for the interment, countersigned by the grave-maker, of the other. The naming of children is without ceremony. Burials are also conducted in a simple manner. The body, followed by the relations and friends, is sometimes, previously to interment, carried to a meeting; and at the grave a pause is generally made; on both which occasions it frequently falls out that one or more friends present have somewhat to express for the edification of those who attend; but no religious rite is considered as an essential part of burial.

"Several monthly-meetings compose a quarterly-meeting. At the quarterly-meeting are produced written answers from the monthly-meetings, to certain queries respecting the conduct of their members, and the meeting's care over them. The accounts thus received are digested into one, which is sent, also in the form of answers to queries, by representatives, to the yearly-meeting.—Appeals from the judgment of monthly-meetings are brought to the quarterly-meetings; whose business also it is to assist in any difficult case, or where remissness appears in the care of the monthly-meetings over the individuals who compose them.

"The yearly-meeting has the general superintendance of the society in the country in which it is established (c); and therefore, as the accounts which it receives discover the state of inferior meetings, as particular exigencies require, or as the meeting is impressed with a sense of duty, it gives forth its advice, makes such regulations as appear to be requisite, or excites to the observance of those already made; and sometimes appoints committees to visit those quarterly-meetings which appear to be in need of immediate help. Appeals from the judgment of quarterly-meetings are here finally determined; and a brotherly correspondence, by epistles, is maintained with other yearly-meetings.

"In this place it is proper to add, that as we believe women may be rightly called to the work of the ministry, we also think, that to them belongs a share in the support of our Christian discipline; and that some parts of it, wherein their own sex is concerned, devolve on them with peculiar propriety. Accordingly they have monthly, quarterly, and yearly-meetings of their own sex, held at the same time and in the same place with those of the men; but separately, and without the power of making rules: and it may be remarked, that during the persecutions, which in the last century occasioned the imprisonment of so many of the men, the care of the poor often fell on the women, and was by them satisfactorily administered.

"In order that those who are in the situation of ministers may have the tender sympathy and counsel of those of either sex, who, by their experience in the work of religion, are qualified for that service; the monthly-meetings are advised to select such, under the denomination of *elders*. These, and ministers approved by their monthly-meetings (d), have meetings peculiar to themselves, called meetings of ministers and elders; in

(c) "There are seven yearly meetings, viz. 1st, London, to which come representatives from Ireland; 2d, New-England; 3d, New-York; 4th, Pennsylvania and New-Jersey; 5th, Maryland; 6th, Virginia; 7th, the Carolinas and Georgia."

(d) "Those who believe themselves required to speak in meetings for worship, are not immediately acknowledged as ministers by their monthly-meetings; but time is taken for judgment, that the meeting may be satisfied of their call and qualification. It will also sometimes happen, that such as are not approved, will obtrude themselves as ministers, to the grief of their brethren; but much forbearance is used towards these, before the disapprobation of the meeting is publicly testified."

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"It is to a meeting of this kind held in London, called the ſecond-day morning-meeting, that the reviſal of manuſcripts concerning our principles, previouſly to publication, is intruſted by the yearly-meeting held in London; and alſo the granting, in the intervals of the yearly-meeting, certificates of approbation to ſuch miniſters as are concerned to travel in the work of the miniſtry in foreign parts. When a viſit of this kind doth not extend beyond Great Britain, a certificate from the monthly-meeting of which the miniſter is a member is ſufficient; if to Ireland, the concurrence of the quarterly-meeting is alſo required. Regulations of ſimilar tendency obtain in other yearly-meetings.

"The yearly-meeting held in London, in the year 1675, appointed a meeting to be held in that city, for the purpoſe of adviſing and aſſiſting in caſes of ſuffering for conſcience ſake, which hath continued with great uſe to the ſociety to this day. It is compoſed of friends under the name of correſpondents, choſen by the ſeveral quarterly-meetings, and who reſide in or near the city. The ſame meetings alſo appoint members of their own in the country as correſpondents, who are to join their brethren in London on emergency. The names of all theſe correſpondents, previous to their being recorded as ſuch, are ſubmitted to the approbation of the yearly-meeting. Thoſe of the men who are approved miniſters are alſo members of this meeting, which is called the *meeting* for *ſufferings*; a name ariſing from its original purpoſe, which is not yet become entirely obſolete.

"The yearly-meeting has intruſted the meeting for ſufferings with the care of printing and diſtributing books, and with the management of its ſtock; and conſidered as a ſtanding committee of the yearly-meeting, it hath a general care of whatever may ariſe, during the intervals of that meeting, affecting the ſociety, and requiring immediate attention: particularly of thoſe circumſtances which may occaſion an application to government.

"There is not in any of the meetings which have been mentioned any preſident, as we believe that Divine Wiſdom alone ought to preſide; nor hath any member a right to claim pre-eminence over the reſt. The office of clerk, with a few exceptions, is undertaken voluntarily by ſome member; as is alſo the keeping of the records. Where theſe are very voluminous, and require a houſe for their depoſite (as is the caſe in London, where the general records of the ſociety in Great Britain are kept), a clerk is hired to have the care of them; but except a few clerks of this kind, and perſons who have the care of meeting-houſes, none receive any ſtipend or gratuity for their ſervices in our religious ſociety."

Quality. It is remarkable, that all the ſettlements of the Europeans in America, except the Quakers ſettlement of Pennſylvania, were made by force of arms, with very little regard to any prior title in the natives. The kings of Spain, Portugal, France, and Britain, together with the States of Holland, then the only maritime powers, gave grants of ſuch parts of America as their people could lay hold on, ſtudying only to avoid interference with their European neighbours. But Mr Penn, being a Quaker, did not think his power from King Cha. II. a ſufficient title to the country ſince called *Pennſylvania*: He therefore aſſembled the ſachems or princes then in that country, and purchaſed from them the extent of land that he wanted. The government of this province is moſtly in the hands of the Quakers, who never have any quarrels with the natives. When they deſire to extend their ſettlements, they purchaſe new lands of the ſachems, never taking any thing from them by force. How unlike is this conduct to that of the Spaniards, who murdered millions of the natives of Mexico, Terra Firma, Peru, Chili, &c.

Quality characterized by Ariſtotle. QUALITY is a word which, as uſed in philoſophical diſquiſitions, cannot be explained by any periphraſis. That which is expreſſed by it muſt be brought into the immediate view of the ſenſes or intellect, and the name properly applied, or he who is a ſtranger to the word will never be made to comprehend its meaning. Ariſtotle, who treated it as a general conception ſecond in order among the ten *predicaments* or *categories* (ſee CATEGORY), gives ſeveral characters of it; but though they are all in ſome reſpects juſt, no man could from them, without other aſſiſtance, learn what *quality* is. Thus he tells us *, Τ'παρχει δε ενανπιοτης καλα το ποιον; Επιδεχεται δε το μαλλον και το ἡττον τα ποια. And again, Ο'μοια δε η ανομοια καλα μονας τας ποιοτηπας λεγεται· ὁμοιον γαρ ἑτερον ἑτερω ουκ εστι καθ' αλλο ουδεν, η καθ' ὁ ποιον εστιν.

* *Prad.* edit. p. 44, 45.

When a man comprehends, by means of his ſenſes and intellect, what it is which the word *quality* denotes, he will indeed perceive that the firſt of theſe characters is applicable to ſome qualities and not to others; that the ſecond is more applicable to *quantity* than to quality; and that it is only the third which can with propriety be conſidered as the general characteriſtic of this predicament. Thus when we have learned by our ſenſe of ſight that *whiteneſs* is a quality of ſnow, and *blackneſs* of coal; and by means of obſervation and reflection, that *wiſdom* is a quality of one man and *folly* of another—we muſt admit that the ſenſible quality of the ſnow is *contrary* to that of the coal, and the intellectual quality of wiſdom contrary to that of folly. There is, however, no contrariety between *wiſdom* and *whiteneſs* or *blackneſs*, nor between *hardneſs* or *ſoftneſs*, and *any particular colour*; for ſenſible and intellectual qualities can never be compared; and it is not eaſy, if poſſible, to make a compariſon between qualities perceptible only by different ſenſes: Nay, among qualities perceptible by the ſame ſenſe, we often meet with a difference where there is no contrariety; for though the *figure* of a *cube* is *different* from that of a *ſphere*, and the figure of a *ſquare* from that of a *circle*, the ſphere is not *contrary* to the cube, nor the circle to the ſquare.

His ſecond characteriſtic of this genus is ſtill leſs proper than the firſt. It is indeed true that ſome qualities admit of *intenſion* and *remiſſion*; for ſnow is whiter than paper, and one woman is handſomer than another; but

Quality. of the ſpecies of quality called *figure* we cannot predicate either *more* or *leſs*. A crown-piece may have as much of the *circular quality* in it as the plane of the equator, and a muſket-bullet as much of the *ſpherical quality* as the orb of the ſun. It is indeed a property of all *quantity* to admit of *intenſion* and *remiſſion*; and therefore this ought to have been given as the character not of the ſecond but of the third category. See QUANTITY.

2 Nothing known but qualities.

That it is only from a *compariſon of their qualities that things are denominated like or unlike*, or that *one thing cannot reſemble another but in ſome quality*, is indeed a juſt obſervation. We know nothing directly but qualities ſenſible and intellectual (ſee METAPHYSICS, n° 149, 150, 151, and 227); and as theſe have no reſemblance to each other, we conclude that body or matter, the ſubject of the former, is a being unlike mind, the ſubject of the latter. Even of bodies themſelves we can ſay, that one is like or unlike another only by virtue of their qualities. A ball of ivory reſembles a ball of ſnow in its *figure* and *colour*, but not in its *coldneſs* or *hardneſs*; a ball of lead may reſemble a ball of ſnow in its *figure* and *coldneſs*, but not in its *colour*; and a cube of ivory reſembles not a ball of lead either in *figure*, *colour*, or *coldneſs*. The mind of a brute reſembles that of a man in its powers of *ſenſation* and *perception*, but does not reſemble it in the powers of *volition* and *reaſoning*; or at leaſt, the reſemblance, in this latter inſtance, is very ſlight. All bodies reſemble one another in being ſolid and extended, and all minds in being more or leſs active. *Likeneſs* or *unlikeneſs* therefore is the univerſal characteriſtic of the category *quality*.

3 Important diſtinctions of quality,

Ariſtotle has other ſpeculations reſpecting quality, which are worthy of notice. He diſtinguiſhes between qualities which are *eſſential* and thoſe which are *accidental*; between qualities which are *natural* and thoſe which are *acquired*; and he ſpeaks of the qualities of *capacity* and thoſe of *completion*. *Extenſion* and *figure* in *general* are qualities eſſential to all bodies; but a *particular* extenſion, ſuch as an *inch* or an *ell*, and a *particular* figure, ſuch as a *cube* or a *ſphere*, are qualities accidental to bodies. Among the *natural* qualities of glaſs it is one to tranſmit objects of viſion; but to enlarge theſe objects is an *adventitious* or *acquired* quality. The ſame quality may be *natural* in one ſubſtance, as attraction in the magnet; and *acquired* in another, as the ſame attraction in the magnetic bar. *Docility* may be called a quality *natural* to the mind of man, ſcience an *acquired* one. To underſtand what he means by qualities of *capacity* and *completion*, it may be ſufficient to obſerve that every piece of iron has the qualities of a razor in *capacity*, becauſe it may be converted into ſteel, and formed into a razor: when it is ſo formed, it has, in the language of this ſage, the quality of a razor in *completion*. Among the qualities of *capacity* and *completion*, the moſt important, and what may lead to intereſting ſpeculations, is the reaſoning faculty of man. A *capacity* of reaſoning is eſſential to the human mind; but the *completion* of this capacity or *actual reaſoning* is not, otherwiſe *infants* and perſons *aſleep* would be excluded from the human ſpecies.

4 Overlooked by Locke.

Mr Locke has puzzled his readers, and perhaps himſelf, with a queſtion reſpecting the ſpecies of an idiot or changeling, whom he pronounces to be ſomething between a man and a brute *. It is not often that we feel ourſelves inclined to regret Locke's ignorance of Ariſtotle's diſtinctions; but we cannot help thinking, that had the Britiſh philoſopher attended to the Stagyrite's account of qualities in *capacity* and qualities in *completion*, this perplexing queſtion would never have been ſtarted. It is juſtly obſerved in the *Eſſay on Human Underſtanding*, that of *real eſſences* we know nothing: but that every man ſelects a certain number of qualities which he has always perceived united in certain beings; and forming theſe into one complex conception, gives to this conception a *ſpecific* name, which he applies to every being in which he finds thoſe qualities united. This is undoubtedly the proceſs of the mind in forming genera and ſpecies; and as the excellent author refuſes the name of *man* to the changeling, it is obvious that the complex conception, to which he gives that name, muſt imply *rationality* or the *actual exerciſe* of reaſon. But this limitation will exclude many beings from the ſpecies *man*, whom Mr Locke certainly conſidered as men and women. Not to mention infants and perſons in ſound ſleep, how ſhall we claſs thoſe who, after having lived 30 or 40 years in the full exerciſe of reaſon, have been ſuddenly or by degrees deprived of it by ſome diſorder in the brain?

> From Marlb'rough's eyes the ſtreams of dotage flow;
> And Swift expires a driveller and a ſhow.
>
> JOHNSON.

But were the hero and the wit in thoſe deplorable circumſtances excluded from the human ſpecies, and claſſed between men and brutes? No ſurely; they were both acknowledged to be men, becauſe they were known to have the quality of reaſon in what Ariſtotle would have called *capacity*. Their dotage and drivelling originated from ſome diſorder in their bodies, probably in the region of the brain; and Locke himſelf contends that no defect in body is ſufficient to degrade a perſon from the rank of manhood. Again, lunatics have the exerciſe of reaſon, except at new and full moon. Are theſe unhappy beings ſometimes men and ſometimes a ſpecies by themſelves between men and brutes?

5 Strange conſequence of this overſight.

Fallacy of his doctrine reſpecting the human ſpecies.

It appears, therefore, that *not* the *actual exerciſe* of reaſon, but reaſon in *capacity*, ought to be included in the complex conception to which we give the ſpecific name of *man*, as ſome of the greateſt men that ever lived have been during parts of their lives deprived of the power of *actual reaſoning*. This, however, it will be ſaid, does not remove the difficulty; for the occaſional exerciſe of reaſon in lunatics, and the great exertions of it in ſuch men as Swift and Marlborough, ſhow that they had it in *capacity* at all times; whereas we have no evidence that changelings have even a *capacity* of reaſoning at any time, ſince they never do a rational action, nor ever utter a ſentence to the purpoſe. That we have no *direct* and *poſitive* evidence of the minds of changelings being capable of reaſoning, were they ſupplied with proper organs, muſt be granted; but the probabilities of their being ſo are many and great. We know by experience that the actual exerciſe of reaſon may be interrupted by an occaſional and accidental preſſure on the brain: and therefore we cannot doubt but that if this preſſure were rendered permanent by any wrong configuration of the ſkull given to it in the womb, or in the act of being born into the world, an infant, with a mind capable of reaſoning by means of proper organs,

* Book iv. ch. 4. § 13, &c.

Quality
Quang-tong.

would by this accident be rendered, through the whole of life, an idiot or changeling. That idiotism is caused by such accidents, and is not the quality of an inferior mind occasionally given to a human body, will at least seem probable from the following considerations.

7 True doctrine.

It does not appear that an animal body can live and move but while it is actuated by some mind. Whence then does the unborn infant derive its mind? It must be either immediately from God, or *ex traduce* from its parents; but if the mind of man be immaterial, it cannot be *ex traduce*. Now, as idiots are very few in number when compared with the rational part of the human species, and as God in the government of this world acts not by partial but by general laws; we must conclude that the law which he has established respecting the union of mind and matter, is, that human bodies shall be animated with minds endowed with a capacity of reasoning, and that those who never exert this capacity are prevented by some such accident as we have assigned.

For a further account of qualities, why they are supposed to inhere in some subject, together with the usual distinction between the primary and secondary qualities of matter, see METAPHYSICS, Part II. Chap. i.

Chemical QUALITIES, those qualities principally introduced by means of chemical experiments, as fumigation, amalgamation, cupellation, volatilization, precipitation, &c.

QUALITY, is also used for a kind of title given to certain persons, in regard of their territories, signiories, or other pretensions.

QUANGA, See CAPRA.

QUANG-PING-FOU, a city in China, is situated in the northern part of the province of Pe-tcheli, between the provinces of Chang-tong and Ho-nan, and has nine cities of the third class dependent on it; all its plains are well watered by rivers. Among its temples, there is one dedicated to those men who, as the Chinese pretend, discovered the secret of rendering themselves immortal.

QUANGSI, a province of China, bounded on the north by Koe-Tcheau and Hu-Quang; on the east, by Yunan and Quantong; on the south, by the same and Ton-quin; and on the west, by Yun-nan. It produces great plenty of rice, being watered by several large rivers. The southern part is a flat country, and well cultivated; but the northern is full of mountains covered with trees. It contains mines of all sorts; and there is a gold-mine lately opened. The capital town is Quie-ling.

A very singular tree, says Grosier, grows in this province; instead of pith, it contains a soft pulp; which yields a kind of flour: the bread made of it is said to be exceedingly good. Besides paroquets, hedgehogs, porcupines, and rhinoceroses, a prodigious number of wild animals, curious birds, and uncommon insects, are found here.

This province contains 12 villages of the first class, and 80 of the second and third.

QUANG-TONG, a province of China, bounded on the east by Kiang-si and Fokien; on the south, by the ocean; and on the west, by Tonquin. This province is diversified by valleys and mountains; and yields two crops of corn in a year. It abounds in gold, jewels, silk, pearls, tin, quicksilver, sugar, brass, iron, steel, saltpetre, ebony, and several sorts of odoriferous wood; besides fruits of all sorts proper to the climate. They have a prodigious number of ducks, whose eggs they hatch in ovens; and a tree, whose wood is remarkably hard and heavy, and thence called *iron-wood*. The mountains are covered with a sort of osiers which creep along the ground, and of which they make baskets, hurdles, matts, and ropes. Quantity.

Although the climate of this province is warm, the air is pure, and the people are robust and healthy. They are very industrious; and it must be allowed that they possess in an eminent degree the talent of imitation: if they are only shown any of our European works, they execute others like them with the most surprising exactness. This province suffered much during the civil wars; but at present it is one of the most flourishing in the empire; and, as it is at a great distance from court, its government is one of the most important. This province is divided into ten districts, which contain 10 cities of the first class, and 84 of the second and third. Canton is the capital town.

1 Quantity

QUANTITY, as explained by the great English lexicographer, is that property of any thing which may be increased or diminished. This interpretation of the *word* is certainly just, and for the purposes of common conversation it is sufficiently determinate; but the man of science may expect to find in a work like ours a definition of the *thing* signified. This, however, cannot be given him. A logical definition consists of the *genus* under which the thing defined is ranked, and the *specific* difference (see LOGIC, n° 20, &c.); but quantity is ranked under no genus. In that school where such definitions were most valued, it was considered as one of the ten *categories*, or general conceptions, under which all the objects of human apprehension were mustered, like soldiers in an army (see CATEGORY and PHILOSOPHY, n° 22.) On this account, even Aristotle himself, who delighted in definitions, and was not easily deterred from a favourite pursuit, could not consistently with his own rules attempt to define *quantity*. He characterizes it, however, in several parts of his works; and particularly in the 15th chapter of the 4th book of his metaphysics, where he gives the following account of the three first *categories*: Ἰσότα μὲν γὰρ, οὗ μία ἡ οὐσία. ὅμοια δ' ὧν ἡ ποιότης μία ἴσα δὲ, ὧν τὸ ποσὸν ἕν. "Things are the *same*, of which the SUBSTANCE is one; *similar*, of which the QUALITY is one; *equal*, of which the QUANTITY is one. Again, he tells us*, that the chief characteristic of quantity is, that it may be denominated *equal* and *unequal*.

2 Characterized by Aristotle.

* Pred. p. 34. edit. Sylb.

That any man can become wiser by reading such descriptions as these, none but an idolater of Aristotle will suppose. There is, indeed, no periphrasis by which we can explain what is meant by quantity to those who have not previously formed such a notion.—All that can be done by making the attempt is only to settle language, by stating exactly the cases in which we use this word in the greatest conformity to general custom; for there is a laxness or carelessness of expression in the language of most men, and our notions are frequently communicated by speech in a way by no means precise; so that it is often a great chance that the notions excited in the mind of the hearer are not exact counterparts of those in the mind of the speaker.

The

Quantity. The underſtandings of men differ in nothing more remarkably than in their power of abſtraction, and of rapidly forming conceptions ſo general and ſimple as not to be clogged with diſtinguiſhing circumſtances, which may be different in different minds while uttering and hearing the ſame words: and it is of great conſequence to a man of ſcientific habits, either to cultivate, if poſſible, this talent, or to ſuperſede its uſe, by ſtudiouſly forming to himſelf notions of the moſt important *univerſals* in his own courſe of contemplation, by careful abſtraction of every thing extraneous. His language by this means becomes doubly inſtructive by its extreme preciſion; and he will even judge with greater certainty of notions intended to be communicated by the more ſlovenly language of another perſon.

We cannot ſay that there is much ambiguity in the general uſe of the term *quantity*: But here, as in all other caſes, a love of refinement, of novelty, and frequently of vanity, and the wiſh of appearing ingenious and original, have made men take advantage of even the ſmall latitude with which the careleſs uſe of the word will furniſh them, to amuſe themſelves and the public by giving the appearance of ſcience to empty ſounds.

3 The ſubject of mathematical reaſoning

Mathematics is undoubtedly employed in diſcovering and ſtating many relations of quantity; and it is in this category alone that any thing is contemplated by the mathematician, whether in geometry, arithmetic, or algebra. Hence mathematics has been called the ſcience of quantity. The ſimplicity of the object of the mathematician's contemplation, and the unparalleled diſtinctneſs with which he can perceive its modifications, have enabled him to erect a body of ſcience, eminent not only for its certainty, but alſo for the great length to which he can carry his reaſonings without danger of error; and the intimate connection which this ſcience has with the arts of life, and the important ſervices which it has performed, have procured it a moſt reſpectable place in the circle of the ſciences. Ingenious men have availed themſelves of this pre-eminence of mathematics, and have endeavoured to procure reſpect for their diſquiſitions on other ſubjects, by preſenting them to the public as branches of mathematical ſcience, and therefore ſuſceptible of that accuracy and certainty which are its peculiar boaſt. Our moral affections, our ſenſations, our intellectual powers, are all ſuſceptible of augmentation and diminution, are conceivable as greater and leſs when ſtated together, and are familiarly ſpoken of as admitting of degrees of compariſon. We are perfectly well underſtood when we ſay that one pain, heat, grief, kindneſs, is greater than another; and as this is the diſtinguiſhing characteriſtic of quantity, and as quantity is the ſubject of mathematical diſcuſſion, we ſuppoſe that theſe ſubjects may be treated mathematically. Accordingly, a very celebrated and excellent philoſopher* has ſaid, among many things of the ſame kind, that the greatneſs of a favour is in the direct compound ratio of the ſervice performed and the dignity of the performer, and the inverſe ratio of the merit and rank of the receiver; that the value of a character is in the compound ratio of the talents and virtue, &c.; and he has delivered a number of formal propoſitions on the moſt intereſting queſtions in morals, couched in this mathematical language, and even expreſſed by algebraic formulæ. But this is mere play, and conveys no inſtruction. We underſtand the words; they contain no abſurdity; and in as far as they have a ſenſe, we believe the propoſitions to be true. But they give no greater preciſion to our ſentiments than the more uſual expreſſions would do. If we attend cloſely to the meaning of any one of ſuch propoſitions, we ſhall find that it only expreſſes ſome vague and indiſtinct notions of degrees of thoſe emotions, ſentiments, or qualities, which would be juſt as well conceived by means of the expreſſions of ordinary language; and that it is only by a ſort of analogy or reſemblance that this mathematical language conveys any notions whatever of the ſubjects.

Quantity.

4 Which is improperly introduced into other ſubjects.

5 The mathematician contemplates only quantities that are meaſurable.

The object of contemplation to the mathematician is not whatever is ſuſceptible of greater and leſs, but what is meaſurable; and mathematics is not the ſcience of magnitude, in its moſt abſtracted and general acceptation, but of magnitude which can be meaſured. It is, indeed, the SCIENCE of MEASURE, and whatever is treated in the way of menſuration is treated mathematically. Now, in the diſcourſe of ordinary life and ordinary men, many things are called quantities which we cannot or *do not* meaſure. This is the caſe in the inſtances already given of the affections of the mind, pleaſure, pain, beauty, wiſdom, honour, &c. We do not ſay that they are incapable of meaſure; but we have not yet been able to meaſure them, nor do we think of meaſuring them when we ſpeak rationally and uſefully about them. We therefore do not conſider them mathematically; nor can we introduce mathematical preciſion into our diſcuſſions of theſe ſubjects till we can, and actually do, meaſure them. Perſons who are preciſe in their expreſſion will even avoid ſuch phraſes on theſe ſubjects as ſuppoſe, or ſtrictly expreſs, ſuch meaſurement. We ſhould be much embarraſſed how to anſwer the queſtion, How much pain does the toothache give you juſt now; and how much is it eaſier ſince yeſterday? Yet the anſwer (if we had a meaſure) would be as eaſy as to the queſtion, How many guineas did you win at cards? or how much land have you bought? Nay, though we ſay familiarly, "I know well how much ſuch a misfortune would affect you," and are underſtood when we ſay it, it would be aukward language to ſay, "I know well the quantity of your grief." It is in vain, therefore, to expect mathematical preciſion in our diſcourſe or conceptions of quantities in the moſt abſtracted ſenſe. Such preciſion is confined to quantity which may be and is meaſured (A). It is only.

* *Dr Francis Hutchinſon.*

(A) To talk intelligibly of the quantity of a pain, we ſhould have ſome ſtandard by which to meaſure it; ſome known degree of it ſo well aſcertained, that all men, when talking of it, ſhould mean the ſame thing.—And we ſhould be able to compare other degrees of pain with this, ſo as to perceive diſtinctly, not only whether they exceed or fall ſhort of it, but alſo how much, or in what proportion; whether by an half, or a fifth, or tenth. *Reid.*

Quantity. only trifling with the imagination when we employ mathematical language on ſubjects which have not this property.

It will therefore be of ſome ſervice in ſcience to diſcriminate quantities in this view; to point out what are ſuſceptible of meaſure, and what are not.

6 Meaſuring explained. What is meaſuring? It is one of theſe two things: It is either finding out ſome known magnitude of the thing meaſured, which we can demonſtrate to be equal to it; or to find a known magnitude of it, which being taken ſo many times ſhall be equal to it. The geometer meaſures the contents of a parabolic ſpace when he exhibits a parallelogram of known dimenſions, and demonſtrates that this parallelogram is equal to the parabolic ſpace. In like manner, he meaſures the ſolid contents of an infinitely extended hyperbolic ſpindle, when he exhibits a cone of known dimenſions, and demonſtrates that three of theſe cones are equal to the ſpindle.

In this proceſs it will be found that he actually ſubdivides the quantity to be meaſured into parts of which it conſiſts, and ſtates theſe parts as actually making up the quantity, ſpecifying each, and aſſigning its boundaries. He goes on with it, piece by piece, demonſtrating the reſpective equalities as he goes along, till he has exhauſted the figure, or conſidered all its parts.—When he meaſures by means of a ſubmultiple, as when he ſhows the ſurface of a ſphere to be equal to four of its great circles, he ſtops, after having demonſtrated the equality of one of theſe circles to one part of the ſurface: then he demonſtrates that there are other three parts, each of which is preciſely equal to the one he has minutely conſidered. In this part of the proceſs he expreſsly aſſigns the whole ſurface into its diſtinct portions, of which he demonſtrates the equality.

But there is another kind of geometrical meaſurement which proceeds on a very different principle. The geometer conceives a certain individual portion of his figure, whether line, angle, ſurface, or ſolid, as known in reſpect to its dimenſions. He conceives this to be lifted from its place, and again laid down on the *adjoining* part of the figure, and that it is equal to the part which it now covers; and therefore that this part together with the firſt is double of the firſt: he lifts it again, and lays it down on the next adjoining part, and affirms that this, added to the two former, make up a quantity triple of the firſt. He goes on in this way, making ſimilar inferences, till he can demonſtrate that he has in this manner covered the whole figure by twenty applications, and that his moveable figure will cover no more; and he affirms that the figure is twenty times the part employed.

This mode is preciſely ſimilar to the manner of practical meaſurement in common life: we apply a foot-rule ſucceſſively to two lines, and find that 30 applications exhauſt the one, while it requires 35 to exhauſt the other. We ſay, therefore, that the one line is 30 and the other 35 feet long; and that theſe two lines are to each other in the ratio of 30 to 35. Having meaſured two ſhorter lines by a ſimilar application of a ſtick of an inch long 30 times to the one and 35 times to the other, we ſay that the ratio of the two firſt lines is the ſame with that of the two laſt. Euclid has taken this method of demonſtrating the fourth propoſition of the firſt book of his celebrated elements.

7 Euclid's fourth propoſition.

But all this proceſs is a fiction of the mind, and it is the fiction of an impoſſibility. It is even *inconceivable*, that is, we cannot in imagination make this application of one figure to another; and we preſume to ſay, that, if the elements of geometry cannot be demonſtrated in ſome other way, the ſcience has not that title to pure, abſtract, and infallible knowledge, which is uſually allowed it. We cannot *ſuppoſe* one of the triangles lifted and laid on the other, without ſuppoſing it ſomething different from a triangle *in abſtracto*. The *individuality* of ſuch a triangle conſiſts ſolely in its being in the preciſe place where it is, and in occupying *that* portion of ſpace. If we could diſtinctly conceive otherwiſe, we ſhould perceive that, when we have lifted the triangle from its place, and applied it to the other, it is gone from its former place, and that there *is* no longer a triangle *there*. This is inconceivable, and ſpace has always been acknowledged to be immoveable. There is therefore ſome logical defect in Euclid's demonſtration. We apprehend that he is labouring to demonſtrate, or rather illuſtrate, a ſimple apprehenſion. This indeed is the utmoſt that can be done in any demonſtration (ſee METAPHYSICS, n° 82.): but the mode by which he guides the mind to the apprehenſion of the truth of his fourth propoſition is not conſiſtent either with pure mathematics or with the laws of corporeal nature. The real proceſs, as laid down by him, ſeems to be this. We ſuppoſe ſomething different from the abſtract triangle; ſome *thing* that, in conjunction with other properties, has the property of being triangular, with certain dimenſions of two of its ſides and the included angle. It has avowedly another property, not eſſential to, and not contained in, the abſtract notion of a triangle, viz. mobility. We alſo ſuppoſe it permanent in ſhape and dimenſions, or that although, *during* its motion, it does not occupy *the ſame ſpace*, it continues, and all its parts, to occupy *an equal ſpace*. In ſhort, our conception is very mixed, and does not perceptibly differ from our conception of a triangular piece of matter, where the triangle is not the ſubject, but an adjunct, a quality. And when we ſuppoſe the application made, we are not in fact ſuppoſing two abſtract triangles to coincide. This we cannot do with any thing like diſtinctneſs; for our diſtinct conception now is, not that of two triangles coinciding, but of one triangle being now exactly occupied by that moveable thing which formerly occupied the other. In ſhort, it is a vulgar meaſurement, reſtricted by ſuppoſitions which are inadmiſſible in all *actual* meaſurements in the preſent univerſe, in which no moveable material thing is *known* to be permanent, either in ſhape or magnitude.

This is an undeniable conſequence of the principle of univerſal gravitation, and the compreſſibility of every kind of tangible matter with which we are acquainted. Remove the braſs rule but one inch from its place; its gravitation to the earth and to the reſt of the univerſe is immediately changed, and its dimenſions change of conſequence. A change of temperature will produce a ſimilar effect; and this is attended to and conſidered in all nice menſurations. We do the beſt we can to aſſure ourſelves that our rule always occupies a ſenſibly equal ſpace; and we muſt be contented with chances of error which we can neither perceive nor remove.

We might (were this a proper place) take notice of ſome other logical defects in the reaſoning of this celebrated propoſition: but they are beſide our preſent purpoſe of explaining the different modes of mathemati-

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Quantity.

cal meaſurement, with the view of diſcovering that circumſtance in which they all agree, and which (if the only one) muſt therefore be the characteriſtic of menſuration.

8 The characteriſtic notion of menſuration.

We think that the only circumſtance in which all modes of menſuration agree, or the only notion that is found in them all, is, that the quantity is conceived as conſiſting of parts, diſtinguiſhable from each other, and ſeparated by aſſignable boundaries; ſo that they are at once conceived ſeparately and jointly. We venture to aſſert that no quantity is directly meaſured which we cannot conceive in this way, and that ſuch quantities only are the immediate objects of mathematical contemplation, and ſhould be diſtinguiſhed by a generic name. Let them be called MATHEMATICAL QUANTITIES. EXTENSION, DURATION, NUMBER, and PROPORTION, have this characteriſtic, and they are the only quantities which have it. Any perſon will be convinced of the firſt aſſertion by attending to his own thoughts when contemplating theſe notions. He will find that he conceives every one of them as made up of its own parts, which are diſtinguiſhable from each other, and have aſſignable boundaries, and that it is only in conſequence of involving this conception that they can be added to or ſubtracted from each other; that they can be multiplied, divided, and conceived in any proportion to each other.

He may perhaps find conſiderable difficulty in acquiring perfectly diſtinct notions of the menſurability, and the accuracy of the modes of menſuration. He will find that the way in which he meaſures duration is very ſimilar to that in which he meaſures ſpace or extenſion. He does not know, or does not attend to, any thing which hinders the braſs foot-rule in his hand from continuing to occupy equal ſpaces during his uſe of it, in meaſuring the diſtance of two bodies. In like manner he ſelects an event which nature or art can repeat continually, and in which the circumſtances which contribute to its accompliſhment are invariably the ſame, or their variations and their effects are inſenſible. He concludes that it will always occupy an equal portion of time for its accompliſhment, or always laſt an equal time. Then, obſerving that, during the event whoſe duration he wiſhes to meaſure, this ſtandard event is accompliſhed 29½ times, and that it is repeated 365¼ times during the accompliſhment of another event, he affirms that the durations of theſe are in the ratio of 29½ to 365¼. It is thus (and with the ſame logical defect as in the meaſuring a line by a braſs rod) that the aſtronomer meaſures the celeſtial revolutions by means of the rotation of the earth round its axis, or by the vibrations of a pendulum.

We are indebted for moſt of the preceding obſervations to Dr Reid, the celebrated author of the Inquiry into the Human Mind on the Principles of Common Senſe, and of the Eſſays on the intellectual and active Powers of Man. He has publiſhed a diſſertation on this ſubject in the 45th volume of the Philoſophical Tranſactions, n° 489, which we recommend to our philoſophical readers as a performance eminent for preciſion and acuteneſs. If we preſume to differ from him in any trivial circumſtance, it is with that deference and reſpect which is due to his talents and his worth.

9 Characters of mathematical quantity.

Dr Reid juſtly obſerves, that as nothing has proportion which has not either extenſion, duration, or number, the characters of mathematical quantity may be reſtricted to theſe three. He calls them PROPER quantities, and all others he calls IMPROPER. We believe that, in the utmoſt preciſion of the Engliſh language, this denomination is very appoſite, and that the word *quantity*, derived from *quantum*, always ſuppoſes meaſurement: But the word is frequently uſed in caſes where its original is not kept in view, and we uſe other words as ſynonymous with it, when all menſuration, whether poſſible or not, is out of our thoughts. According to practice, therefore, the *jus et norma loquendi*, there ſeems to be no impropriety in giving this name, in our language at leaſt, to whatever can be conceived as great or little. There is no impropriety in ſaying that the pain occaſioned by the ſtone is greater than that of the toothache; and when we ſearch for the category to which the aſſertion may be referred, we cannot find any other than quantity. We may be allowed therefore to ſay, with almoſt all our ſcientific countrymen, that every thing is conceivable in reſpect of quantity which we can think or ſpeak of as greater and leſs; and that this notion is the characteriſtic of quantity as a genus, while meaſureableneſs is the characteriſtic of mathematical quantity as a ſpecies.

Quantity.

10 Other quantities that cannot be conſidered mathematically.

But do we not meaſure many quantities, and conſider them mathematically, which have not this characteriſtic of being made up of their own diſtinguiſhable parts? What elſe is the employment of the mechanician, when ſpeaking of velocities, forces, attractions, repulſions, magnetic influence, chemical affinity, &c. &c.? Are not theſe mathematical ſciences? And if the preciſion and certainty of mathematics ariſe from the nature of their ſpecific object, are not all the claims of the mechanician and phyſical aſtronomer ill-founded pretenſions? Theſe queſtions require and deſerve a ſerious anſwer.

11 Velocity, force, denſity, how meaſured.

It is moſt certain that we conſider the notions which are expreſſed by theſe terms velocity, force, denſity, and the like, as ſuſceptible of meaſure, and we conſider them mathematically.

Some of theſe terms are nothing but names for relations of meaſurable quantity, and only require a little reflection to ſhow themſelves ſuch. VELOCITY is one of theſe. It is only a name expreſſing a relation between the ſpace deſcribed by a moving body and the time which elapſes during its deſcription. Certain moderate rates of motion are familiar to us. What greatly exceeds this, ſuch as the flight of a bird when compared with our walking, excites our attention, and this exceſs gets a name. A motion not ſo rapid as we are familiar with, or as we wiſh, alſo gets a name; becauſe in this the exceſs or defect may intereſt us. We wiſh for the flight of the hawk; we chide the tardy pace of our meſſenger: but it is ſcientific curioſity which firſt conſiders this relation as a *ſeparate* object of contemplation, and the philoſopher muſt have a name for it. He has not formed a new one, but makes uſe of a word of common language, whoſe natural meaning is the combination of a great ſpace with a ſhort time. Having once appropriated it, in his ſcientific vocabulary, to this very general uſe, it loſes with him its true ſignification. Tardity would have done juſt as well, though its true meaning is diametrically oppoſite; and there is no greater impropriety in ſaying the tardity of a cannon bullet than in ſaying the velocity of the hour-hand of a watch.

Velocity

Quantity. Velocity is a quality or affection of motion, the notion of which includes the notions of ſpace and duration (two mathematical quantities), and no other. It does not therefore expreſs a mathematical quantity itſelf, but a relation, a combination of two mathematical quantities of different kinds; and as it is meaſurable in the quantities ſo combined, its meaſure muſt be a unit of its own kind, that is, an unit of ſpace *as combined* with an unit of time.

DENSITY is another word of the ſame kind, expreſſing a combination of ſpace with number. *Denſæ arbores* means trees ſtanding at a ſmall diſtance from each other; and the word is uſed in the ſame ſenſe when we ſay that quickſilver is denſer than water. The expreſſion always ſuggeſts to the reflecting mind the notions of particles and their diſtances. We are indeed ſo habituated to complicated views of things, that we can ſee remote connections with aſtoniſhing rapidity; and a very few circumſtances are ſufficient for leading forward the mind in a train of inveſtigation. Common diſcourſe is a moſt wonderful inſtance of this. It is in this way that we ſay, that we found by weighing them that inflammable air had not the ſixth part of the denſity of common air. Suppoſing all matter to conſiſt of equal atoms equally heavy, and knowing that the weight of a bladder of air is the ſum of the weights of all the atoms, and alſo knowing that the *vicinity* of the atoms is in a certain proportion of the *number* contained in a given bulk, we affirm that common air is more than ſix times denſer than inflammable air; but this rapid deciſion is entirely the effect of habit, which makes us familiar with certain groups of conceptions, and we inſtantaneouſly diſtinguiſh them from others, and thus think and diſcourſe rationally. The Latin language employs the word *frequens* to expreſs both the combination of ſpace and number, and that of time and number.

There are perhaps a few more words which expreſs combinations of mathematical quantities of different kinds; and the correſponding ideas or notions are therefore proper and immediate ſubjects of mathematical diſcuſſion: But there are many words which are expreſſive of things, or at leaſt of notions, to which this way of conſidering them will not apply. All thoſe affections or qualities of external bodies, by which they are conceived to act on each other, are of this kind: IMPULSIVE FORCE, WEIGHT, CENTRIPETAL AND CENTRIFUGAL FORCE, MAGNETICAL, ELECTRICAL, CHEMICAL ATTRACTIONS AND REPULSIONS; in ſhort, all that we conſider as the immediate cauſes of natural phenomena. Theſe we familiarly meaſure, and conſider mathematically.

12 Forces meaſured in the phenomena.

What was ſaid on this ſubject in the article PHYSICS will give us clear conceptions of this proceſs of the mind. Theſe forces or cauſes are not immediate objects of contemplation, and are known only *by* and *in* the phenomena which we conſider as their effects. The phenomenon is not only the indication of the agency of any cauſe, and the characteriſtic of its kind, but the meaſure of its degree. The neceſſary circumſtances in this *train of human thought* are, 1ſt, The notion of the force as ſomething ſuſceptible of augmentation and diminution. 2d, The notion of an inſeparable connection of the force with the effect produced, and of every degree of the one with a correſponding degree of the other. From theſe is formed the notion that the phenomenon or effect is the proper meaſure of the force or cauſe. Quantity. All this is ſtrictly logical.

But when we are conſidering theſe ſubjects mathematically, the immediate objects of our contemplation are not the forces which we are thus treating. It is not their relations which we perceive, and which we combine with ſuch complication of circumſtances and certainty of inference as are unknown in all other ſciences: by no means; they are the phenomena only, which are ſubjects of purely mathematical diſcuſſion. They are motions, which involve only the notions of ſpace and time; and when we have finiſhed an accurate mathematical inveſtigation, and make our affirmation concerning the forces, we are certain of its truth, becauſe we *ſuppoſe* the forces to have the proportions and relations, and no other, which we obſerve in the phenomena. Thus, after having demonſtrated, by the geometrical compariſon of the lines and angles and ſurfaces of an ellipſe, that the momentary deflection of the moon from the tangent of her orbit is the 3600th part of the ſimultaneous deflection of a ſtone from the tangent of its parabolic path, Newton affirms, that the force by which a particle of the moon is retained in her orbit is the 3600th part of the weight of a particle of the ſtone; and having farther ſhown, from fact and obſervation, that theſe momentary deflections are inverſely as the ſquares of the diſtances from the centre of the earth, he affirms, that all this is produced by a force which varies its intenſity in this manner.

Now all this inveſtigation proceeds on the two ſuppoſitions mentioned above, and the meaſures of the forces are in fact the meaſures of the phenomena. The whole of phyſical aſtronomy, and indeed the whole of mechanical philoſophy, might be taught and underſtood, without ever introducing the word force, or the notion which it is ſuppoſed to expreſs: for our mathematical reaſonings are really about the phenomena, which are ſubjects purely mathematical.

The preciſion, therefore, that we preſume to affirm to attend theſe inveſtigations, ariſes entirely from the meaſurable nature of the quantities which are the real objects of our contemplation, and the ſuitableneſs and propriety of the meaſures which we adopt in our compariſons.

Since, then, the phenomena are the *immediate* ſubjects of our diſcuſſion, and the operating powers are only inferences from the phenomena conſidered as effects, the quantity aſcribed to them muſt alſo be an inference from the quantity of the effect, or of ſome circumſtance in the effect. The meaſure, therefore, of the cauſe, or natural power or force, cannot be one of its own parts; for the whole and the part are equally unperceived by us. Our meaſure, therefore, muſt be a meaſure of ſome intereſting part, or of the only intereſting part of the phenomenon. It is therefore in a manner arbitrary, and depends chiefly on the intereſt we take in the phenomenon. It muſt, however, be ſettled with preciſion, ſo that all men in uſing it may mean the ſame thing. It muſt be ſettled, therefore, by the deſcription of that part or circumſtance of the phenomenon which is characteriſtic of the natural power. This deſcription is the *definition* of the meaſure.

13 Meaſures of centripetal forces.

Thus Newton aſſumes as his meaſure of the centripetal force, the momentary deviation from uniform rectilineal motion. Others, and ſometimes Newton himſelf,

Quantity. himſelf, aſſumes the momentary change of velocity, which again is meaſured by *twice this deviation*. Theſe meaſures, being thus ſelected, are always proper in a mathematical ſenſe; and if ſtrictly adhered to, can never lead us into any paralogiſm. They may, however, be phyſically wrong: there may not be that indiſſoluble connection between the phenomenon and the ſuppoſed cauſe. But this is no mathematical error, nor does it invalidate any of our mathematical inferences: it only makes them uſeleſs for explaining the phenomenon by the principle which we adopted; but it prepares a modification of the phenomenon for ſome more fortunate application of phyſical principles.

14 Requiſites of ſuch meaſures.

All that can be deſired in the definitions or deſcriptions of theſe meaſures is, that they may not deviate from the ordinary uſe of the terms, becauſe this would always create confuſion, and occaſion miſtakes. Dr Reid has given an example of an impropriety of this kind, which has been the ſubject of much debate among the writers on natural philoſophy. We mean the meaſure of the force inherent in a body in motion. Deſcartes, and all the writers of his time, aſſumed the velocity produced in a body as the meaſure of the force which produces it; and obſerving that a body, in conſequence of its being in motion, produces changes in the ſtate or motion of other bodies, and that theſe changes are in the proportion of the velocity of the changing body, they aſſerted that there is in a moving body a VIS INSITA, an INHERENT FORCE, and that this is proportional to its velocity; ſaying that its force is twice or thrice as great, when it moves twice or thrice as faſt at one time as at another. But Leibnitz obſerved, that a body which moves twice as faſt, riſes four times as high, againſt the uniform action of gravity; that it penetrates four times as deep into a piece of uniform clay; that it bends four times as many ſprings, or a ſpring four times as ſtrong, to the ſame degree; and produces a great many effects which are four times greater than thoſe produced by a body which has half the initial velocity. If the velocity be triple, quadruple, &c. the effects are nine times, 16 times, &c. greater; and, in ſhort, are proportional, not to the velocity, but to its ſquare. This obſervation had been made before by Dr Hooke, who has enumerated a prodigious variety of important caſes in which this proportion of effect is obſerved. Leibnitz, therefore, affirmed, that the force inherent in a moving body is proportional to the ſquare of the velocity.

15 Controverſy between the Carteſians and Leibnitzians on this ſubject.

It is evident that a body, moving with the ſame velocity, has the ſame inherent force, whether this be employed to move another body, to bend ſprings, to riſe in oppoſition to gravity, or to penetrate a maſs of ſoft matter. Therefore theſe meaſures, which are ſo widely different, while each is agreeable to a numerous claſs of facts, are not meaſures of this ſomething inherent in the moving body which we call its force, but are the meaſures of its exertions when modified according to the circumſtances of the caſe; or, to ſpeak ſtill more cautiouſly and ſecurely, they are the meaſures of certain claſſes of phenomena conſequent on the action of a moving body. It is in vain, therefore, to attempt to ſupport either of them by a demonſtration. The meaſure itſelf is nothing but a definition. The Carteſian calls that a double force which produces a double velocity in the body on which it acts. The Leibnitzian calls that a quadruple force which makes a quadruple penetration. The reaſonings of both in the demonſtration of a propoſition in dynamics may be the ſame, as alſo the reſult, though expreſſed in different numbers. Quantity.

But the two meaſures are far from being equally proper: for the Leibnitzian meaſure obliges us to do continual violence to the common uſe of words. When two bodies moving in oppoſite directions meet, ſtrike each other, and ſtop, all men will ſay that their forces are equal, becauſe they have the beſt teſt of equality which we can deviſe. Or when two bodies in motion ſtrike the parts of a machine, ſuch as the oppoſite arms of a lever, and are thus brought completely to reſt, we and all men will pronounce their mutual energies by the intervention of the machine to be equal. Now, in all theſe caſes, it is well known that a perfect equality is found in the products of the quantities of matter and velocity. Thus a ball of two pounds, moving with the velocity of four feet in a ſecond, will ſtop a ball of eight pounds moving with the velocity of one foot per ſecond. But the followers of Leibnitz ſay, that the force of the firſt ball is four times that of the ſecond.

All parties are agreed in calling gravity a uniform or invariable accelerating force; and the definition which they give of ſuch a force is, that it always produces the ſame acceleration, that is, equal accelerations in equal times, and *therefore* produces augmentations of velocity proportionable to the times in which they are produced. The only effect aſcribed to this force, and conſequently the only thing which indicates, characteriſes, and meaſures it, is the augmentation of velocity. What is this velocity, conſidered not merely as a mathematical term, but as a phenomenon, as an event, a production by the operation of a natural cauſe? It cannot be conceived any other way than as a *determination* to move on for ever at a certain rate, if nothing ſhall change it. We cannot conceive this very clearly. We feel ourſelves forced to animate, as it were, the body, and give it not only a will and intention to move in this manner, but a real exertion of ſome faculty in conſequence of this determination of mind. We are conſcious of ſuch a train of operations in ourſelves; and the laſt ſtep of this train is the exertion or energy of ſome natural *faculty*, which we, in the utmoſt propriety of language, call force. By ſuch analogical conception, we ſuppoſe a ſomething, an energy, inherent in the moving body; and its only office is the production and continuation of this motion, as in our own caſe. Scientific curioſity was among our lateſt wants, and language was formed long before its appearance: as we formed analogical conceptions, we contented ourſelves with the words already familiar to us, and to this ſomething we gave the name FORCE, which expreſſed that energy in ourſelves which bears ſome reſemblance (in office at leaſt) to the determination of a body to move on at a certain rate. This ſort of allegory pervades the whole of our conceptions of natural operations, and we can hardly think or ſpeak of any operation without a language, which ſuppoſes the animation of matter. And, in the preſent caſe, there are ſo many points of reſemblance between the effects of our exertions and the operations of nature, that the language is moſt expreſſive, and has the ſtrongeſt appearance of propriety. By exerting our force, we not only move and keep in motion, but we move other bodies. Juſt ſo a ball not only moves,

Quantity. but puts other bodies in motion, or penetrates them, &c.—This is the origin of that conception which ſo forcibly obtrudes itſelf into our thoughts, that there is inherent in a moving body a force by which it produces changes in other bodies. No ſuch thing appears in the ſame body if it be not in motion. We therefore conclude, that it is the production of the moving force, whatever that has been. If ſo, it muſt be conceived as proportional to its producing cauſe. Now this force, thus produced or exerted in the moving body, is only another way of conceiving that determination which we call velocity, when it is conceived as a natural event. We can form no other notion of it. The *vis inſita*, the determination to move at a certain rate, and the velocity, are one and the ſame thing, conſidered in different relations.

16 Vis inſita. Therefore the *vis inſita corpori moventi*, the determination to move at a certain rate, and the velocity, ſhould have one and the ſame meaſure, or any one of them may be taken for the meaſure of the other. The velocity being an object of perception, is therefore a proper meaſure of the inherent force; and the propriety is more evident by the perfect agreement of this uſe of the words with common language. For we conceive and expreſs the action of gravity as uniform, when we think and ſay that its effects are proportional to the times of its action. Now all agree, that the velocity produced by gravity is proportional to the time of its action. And thus the meaſure of force, in reference to its producing cauſe, perfectly agrees with its meaſure, independent of this conſideration.

But this agreement is totally loſt in the Leibnitzian doctrine; for the body which has fallen four times as far, and has ſuſtained the action of gravity twice as long, is ſaid to have four times the force.

The quaintneſs and continual paradox of expreſſion which this meaſure of inherent force leads us into, would have quickly exploded it, had it not been that its chief abettors were leagued in a keen and acrimonious warfare with the Britiſh mathematicians who ſupported the claim of Sir Iſaac Newton to the invention of fluxions. They rejoiced to find in the elegant writings of Huyghens a phyſical principle of great extent, ſuch as this is, which could be ſet in compariſon with ſome of the wonderful diſcoveries in Newton's Principia. The fact, that in the mutual actions of bodies on each other the products of the maſſes and the ſquares of the velocities remain always the ſame (which they

17 Conſervatio virium vivarum. call the *conſervatio virium vivarum)*, is of almoſt univerſal extent; and the knowledge of it enabled them to give ready and elegant ſolutions of the moſt abſtruſe and intricate problem, by which they acquired a great and deſerved celebrity. Dr Robert Hooke, whoſe obſervation hardly any thing eſcaped, was the firſt (long before Huyghens) who remarked *, that in all the caſes of the gradual production and extinction of motion, the ſenſible phenomenon is proportional to the ſquare of the produced or extinguiſhed velocity.

* *Micrographia, vis reſtitutiva*, &c. in his Poſthumous Works.

John Bernoulli brought all theſe facts together, and ſyſtematized them according to the principle advanced by Huyghens in his treatiſe on the centre of oſcillation. He and Daniel Bernoulli gave moſt beautiful ſpecimens of the prodigious uſe of this principle for the ſolution of difficult phyſical problems in their diſſertations on the motion and impulſe of fluids, and on the communication of motion. It was however very early objected to them (we think by Marquis Poleni), that in the colliſion of bodies perfectly hard there was no ſuch *conſervatio virium vivarum;* and that, in this caſe, the forces muſt be acknowledged to be proportional to the velocities. The objections were unanſwerable.—But John Bernoulli evaded their force, by affirming that there were and could be no bodies perfectly hard. This was the origin of another celebrated doctrine, on which Leibnitz greatly plumed himſelf, THE LAW OF CONTINUITY, viz. that nothing is obſerved to change abruptly, or *per ſaltum*. But no one will pretend to ſay that a perfectly hard body is an inconceivable thing; on the contrary, all will allow that ſoftneſs and compreſſibility are adjunct ideas, and not in the leaſt neceſſary to the conception of a particle of matter, nay totally incompatible with our notion of an ultimate atom.

18 Law of continuity.

Sir Iſaac Newton never could be provoked to engage in this diſpute. He always conſidered it as a wilful abuſe of words, and unworthy of his attention. He guarded againſt all poſſibility of cavil, by giving the moſt preciſe and perſpicuous definitions of thoſe meaſures of forces, and all other quantities which he had occaſion to conſider, and by carefully adhering to them. And in one propoſition of about 20 lines, viz. the 39th of the 1ſt book of the Principia, he explained every phenomenon adduced in ſupport of the Leibnitzian doctrine, ſhowing them to be immediate conſequences of the action of a force meaſured by the velocity which it produces or extinguiſhes. There it appears that the heights to which bodies will riſe in oppoſition to the uniform action of gravity are as the ſquares of the initial velocities: So are the depths to which they will penetrate uniformly reſiſting matter: So is the number of equal ſprings which they will bend to the ſame degree, &c. &c. &c. We have had frequent occaſion to mention this propoſition as the moſt extenſively uſeful of all Newton's diſcoveries. It is this which gives the immediate application of mechanical principles to the explanation of natural phenomena. It is inceſſantly employed in every problem by the very perſons who hold by the other meaſure of forces, although ſuch conduct is virtually giving up that meaſure. They all adopt, in every inveſtigation, the two theorems $f t = v$, and $f s = v v$; both of which ſuppoſe an accelerating force f proportional to the velocity v which it produces by its uniform action during the time t, and the theorem $f f s = v^2$ is the 39th 1. Princip. and is the *conſervatio virium vivarum*.

19 Great ſuperiority of Newton.

This famous diſpute (the only one in the circle of mathematical ſcience) has led us ſomewhat aſide. But we have little more to remark with reſpect to meaſurable quantity. We cannot ſay what varieties of quantity are ſuſceptible of ſtrict meaſure, or that it is impoſſible to give accurate meaſures of every thing ſuſceptible of augmentation and diminution. We affirm, however, with confidence, that pain, pleaſure, joy, &c. are not made up of their own parts, which can be contemplated ſeparately: but they may chance to be aſſociated by nature with ſomething that is meaſurable; and we may one day be able to aſſign their degrees with as much preciſion as we now aſcertain the degrees of warmth by the expanſion of the fluid in the thermometer. There is one ſenſe in which they may all be

Quantity ‖ Quarels.

be meaſured, viz. numerically, as Newton meaſures denſity, *vis motrix*, &c. We can conceive the pain of each of a dozen men to be the ſame. Then it is evident that the pain of eight of theſe men is to that of the remaining four as two to one; but from ſuch menſuration we do not foreſee any benefit likely to ariſe.

QUANTITY, in grammar, an affection of a ſyllable, whereby its meaſure, or the time wherein it is pronounced, is aſcertained; or that which determines the ſyllable to be long or ſhort.

Quantity is alſo the object of proſody, and diſtinguiſhes verſe from proſe; and the economy and arrangement of quantities, that is, the diſtribution of long and ſhort ſyllables, makes what we call the *number*. See POETRY, Part III.

The quantities are uſed to be diſtinguiſhed, among grammarians, by the characters ˘, ſhort, as pĕr; and —, long, as rōs. There is alſo a common, variable, or dubious quantity; that is, ſyllables that are one time taken for ſhort ones, and at another time for long ones; as the firſt ſyllable in *Atlas*, *patres*, &c.

QUARANTINE, is a trial which ſhips muſt undergo when ſuſpected of a peſtilential infection. It may be ordered by the king, with advice of the privy-council, at ſuch times, and under ſuch regulations, as he judges proper. Ships ordered on quarantine muſt repair to the place appointed, and muſt continue there during the time preſcribed (generally ſix weeks); and muſt have no intercourſe with the ſhore, except for neceſſary proviſions, which are conveyed with every poſſible precaution. When the time is expired, and the goods opened and expoſed to the air as directed, if there be no appearance of infection they are admitted to port.

Ships infected with the peſtilence muſt proceed to St Helen's Pool in the Scilly iſlands, and give notice of their ſituation to the cuſtomhouſe officers, and wait till the king's pleaſure be known.

Perſons giving falſe information to avoid performing quarantine, or refuſing to go to the place appointed, or eſcaping, alſo officers appointed to ſee quarantine performed, deſerting their office, neglecting their duty, or giving a falſe certificate, ſuffer death as felons.

Goods from Turkey, or the Levant, may not be landed without licenſe from the king, or certificate that they have been landed and aired at ſome foreign port. See PLAGUE.

QUARLES (Francis), the ſon of James Quarles clerk to the board of green cloth and purveyor to queen Eliſabeth, was born in 1592. He was educated at Cambridge; became a member of Lincoln's inn; and was for ſome time cup-bearer to the Queen of Bohemia, and chronologer to the city of London. It was probably on the ruin of her affairs that he went to Ireland as ſecretary to archbiſhop Uſher; but the troubles in that kingdom forcing him to return, and not finding affairs more at peace in England, ſome diſquiets he met with were thought to have haſtened his death, which happened in 1644. His works both in proſe and verſe are numerous, and were formerly in great eſteem, particularly his Divine Emblems: but the obſolete quaintneſs of his ſtyle has cauſed them to fall into neglect, excepting among particular claſſes of readers. "The memory of Quarles, ſays a late author, has been branded with more than common abuſe, and he ſeems to have been cenſured merely from the want of being read. If his poetry failed to gain him friends and readers, his piety ſhould at leaſt have ſecured him peace and goodwill. He too often, no doubt, miſtook the enthuſiaſm of devotion for the inſpiration of fancy; to mix the waters of Jordan and Helicon in the ſame cup, was reſerved for the hand of Milton; and for him, and him only, to find the bays of Mount Olivet equally verdant with thoſe of Parnaſſus. Yet, as the effuſions of a real poetical mind, however thwarted by untowardneſs of ſubject, will be ſeldom rendered totally abortive, we find in Quarles original imagery, ſtriking ſentiment, fertility of expreſſion, and happy combinations; together with a compreſſion of ſtyle that merits the obſervation of the writers of verſe. Groſs deficiencies of judgment, and the infelicity of his ſubjects, concurred in ruining him. Perhaps no circumſtance whatever can give a more complete idea of Quarles's degradation than a late edition of his Emblems; the following paſſage is extracted from the preface: 'Mr Francis Quarles, the author of the Emblems that go under his name, was a man of the moſt exemplary piety, and had a deep inſight into the myſteries of our holy religion. But, for all that, the book itſelf is written in ſo old a language, that many parts of it are ſcarce intelligible in the preſent age; many of his phraſes are ſo affected, that no perſon, who has any taſte for reading, can peruſe them with the leaſt degree of pleaſure; many of his expreſſions are harſh, and ſometimes whole lines are included in a parentheſis, by which the mind of the reader is diverted from the principal object. His Latin mottos under each cut can be of no ſervice to an ordinary reader, becauſe he cannot underſtand them. In order, therefore, to accommodate the public with an edition of Quarles's Emblems properly moderniſed, this work was undertaken.' Such an exhibition of Quarles is chaining Columbus to an oar, or making John Duke of Marlborough a train-band corporal."

Headley's ſelect Beauties of Antient Engliſh Poetry.

Quarries.

QUARRIES, a name commonly given to a moſt extraordinary cavern under the city of Paris, the exiſtence of which is known to few even of the inhabitants, and many of thoſe who have heard of it conſider the whole as an idle ſtory. Mr Thomas White, however, member of the Royal Medical Society of Edinburgh, &c. who viſited it in 1784, puts the matter beyond a doubt; having, with many others, obtained leave (which is very cautiouſly granted) to inſpect it, having guides and torches with them. He gives the following account of it in the ſecond volume of the Mancheſter Tranſactions. "At the entrance by the *Obſervatoire Royal*, the path is narrow for a conſiderable way; but ſoon we entered large and ſpacious ſtreets, all marked with names, the ſame as in the city; different advertiſements and bills were found, as we proceeded, paſted on the walls, ſo that it had every appearance of a large town ſwallowed up in the earth.

"The general height of the roof is about 9 or 10 feet; but in ſome parts not leſs than 30 and even 40. In many places there is a liquor continually dropping from it, which congeals immediately, and forms a ſpecies of tranſparent ſtone, but not ſo fine and clear as rock cryſtal. As we continued our peregrination, we thought ourſelves in no ſmall danger from the roof, which we found but indifferently propped in ſome places with wood much decayed. Under the houſes, and many of the ſtreets, however, it ſeemed to be tolerably ſecured by immenſe ſtones ſet in mortar; in other parts, where

Quarries. there are only fields or gardens above, it was totally unſupported for a conſiderable ſpace, the roof being perfectly level, or a plane piece of rock. After traverſing about two miles, we again deſcended about 20 ſteps, and here found ſome workmen in a very cold and damp place, propping up a moſt dangerous part, which they were fearful would give way every moment. The path here is not more than three feet in width, and the roof ſo low, that we were obliged to ſtoop conſiderably.

"On walking ſome little diſtance farther, we entered into a kind of ſaloon cut out of the rock, and ſaid to be exactly under the *Egliſe de St Jacques*. This was illuminated with great taſte, occaſioned an agreeable ſurpriſe, and made us all ample amends for the danger and difficulty we had juſt before gone through. At one end was a repreſentation in miniature of ſome of the principal forts in the Indies, with the fortifications, draw-bridges, &c. Cannons were planted with a couple of ſoldiers to each ready to fire. Centinels were placed in different parts of the garriſon, particularly before the governor's houſe; and a regiment of armed men was drawn up in another place with their general in the front. The whole was made up of a kind of clay which the place affords, was ingeniouſly contrived, and the light that was thrown upon it gave it a very pretty effect.

"On the other ſide of this hall was a long table ſet out with cold tongues, bread, and butter, and ſome of the beſt Burgundy I every drank. Now every thing was hilarity and mirth; our fears were entirely diſpelled, and the danger we dreaded the moment before was now no longer thought of. In ſhort, we were all in good ſpirits again, and proceeded on our journey about two miles farther, when our guides judged it prudent for us to aſcend, as we were then got to the ſteps which lead up to the town. We here found ourſelves ſafe at the *Val de Grace*, near to the Engliſh Benedictine convent, without the leaſt accident having happened to any one of the party. We imagined we had walked about two French leagues, and were abſent from the ſurface of the earth betwixt four and five hours.

"There were formerly ſeveral openings into the quarries, but the two I have mentioned, viz. the *Obſervatory* and the *Val de Grace*, are, I believe, the only ones left; and theſe the inſpectors keep conſtantly locked, and rarely open them, except to ſtrangers particularly introduced, and to workmen who are always employed in ſome part by the king. The police thought it a neceſſary precaution to ſecure all the entrances into this cavern, from its having been formerly inhabited by a famous gang of robbers, who infeſted the country for many miles round the city of Paris.

"As to the origin of this quarry, I could not, on the ſtricteſt inquiry, learn any thing ſatisfactory; and the only account I know publiſhed is the following contained in the *Tableaux de Paris, nouvelle edition, tom premier, chapitre 5me, page 12me.*

"For the firſt building of Paris it was neceſſary to get the ſtone in the environs; and the conſumption of it was very conſiderable. As Paris was enlarged, the ſuburbs were inſenſibly built on the ancient quarries, ſo that all that you ſee without is eſſentially wanting in the earth for the foundation of the city: hence proceed the frightful cavities which are at this time found under the houſes in ſeveral quarters. They ſtand upon abyſſes. It would not require a very violent ſhock to throw back the ſtones to the place from whence they have been raiſed with ſo much difficulty. Eight men being ſwallowed up in a gulph 150 feet deep, and ſome other leſs known accidents, excited at length the vigilance of the police and the government, and, in fact, the buildings of ſeveral quarters have been privately propped up; and by this means a ſupport given to theſe obſcure ſubterraneous places which they before wanted. Quarry.

"All the ſuburbs of St James's, Harp-ſtreet, and even the ſtreet of Tournon, ſtand upon the ancient quarries; and pillars have been erected to ſupport the weight of the houſes. What a ſubject for reflections, in conſidering this great city formed and ſupported by means abſolutely contrary! Theſe towers, theſe ſteeples, the arched roofs of theſe temples, are ſo many ſigns to tell the eye that what we now ſee in the air is wanting under our feet."

QUARRY, a place under ground, out of which are got marble, freeſtone, ſlate, limeſtone, or other matters proper for building. See STRATA.

Some limeſtone quarries in Fife are highly worthy the attention of the curious, on account of an amazing mixture of ſea-bodies found in them. One of this kind was opened about the year 1759, at a farm called *Enderteel*, in the neighbourhood of Kirkaldy, belonging to General St Clair.

The flakes of the ſtone, which are of unequal thickneſs, moſt of them from eight to ten inches, lie horizontally, dipping towards the ſea. Each of theſe flakes, when broken, preſents to our view an amazing collection of petrified ſea bodies, as the bones of fiſhes, ſtalks of ſea-weed, vaſt quantities of ſhells, ſuch as are commonly found on thoſe coaſts, beſides ſeveral others of very uncommon figures. In ſome places the ſhells are ſo numerous, that little elſe is to be ſeen but prodigious cluſters or concretions of them. In the uppermoſt ſtratum the ſhells are ſo entire, that the outer cruſt or plate may be ſcraped off with the finger; and the ſtalks of the ſea-weed have a darkiſh colour, not that gloſſy whiteneſs which they have in the heart of the quarry. The ſmalleſt rays or veins of the ſhells are deeply indented on the ſtone, like the impreſſion of a ſeal upon wax. In ſhort, no ſpot at the bottom of the ocean could exhibit a greater quantity of ſea-bodies than are to be found in this ſolid rock; for we have the ſkeletons of ſeveral fiſhes, the *antennæ* or feelers of lobſters, the roots and ſtalks of ſea-weeds, with the very *capſulæ* which contain the ſeed. The place where all theſe curioſities are found is on an eminence about an Engliſh mile from the ſea; and as the ground is pretty ſteep the whole way, it may be 200 feet higher at leaſt.

There are two or three things to be remarked here. 1. That among all the bodies we have mentioned, there are none but what are ſpecifically heavier than water. This holds ſo conſtantly true, that the ſea-weed, which floats in water when the plant is entire, has been ſtripped of the broad leaves, which make it buoyant, before it has been lodged here. 2. The ſhells have been all empty; for the double ones, as thoſe of the flat kind, are always found ſingle, or with one ſide only. 3. The rock ſeems to have been gradually deſerted

Quarry || Quarter.

ſerted by the ſea, and for a long time, waſhed with the tides; for the upper ſurface is all eaten, and hollowed in many places like an honey-comb, juſt as we obſerve in flat rocks expoſed every tide to the acceſs and receſs of the waters. See the article SEA.

QUARRY, or *Quarrel*, among glaziers, a pane of glaſs cut in a diamond form.

Quarries are of two kinds, ſquare and long; each of which are of different ſizes, expreſſed by the number of the pieces that make a foot of glaſs, viz. eighths, tenths, eighteenths, and twentieths: but all the ſizes are cut to the ſame angles, the acute angle in the ſquare quarrels being 77° 19, and 67° 21′ in the long ones.

QUARRY, among hunters, is ſometimes uſed for a part of the entrails of the beaſt taken, given by way of reward to the hounds.

QUARRY, in falconry, is the game which the hawk is in purſuit of, or has killed.

QUARTAN, a meaſure containing the fourth part of ſome other meaſure.

QUARTAN, a ſpecies of intermitting fever. See MEDICINE, n° 153, 158, and 159.

QUARTATION, is an operation by which the quantity of one thing is made equal to a fourth part of the quantity of another thing. Thus when gold allayed with ſilver is to be parted, we are obliged to facilitate the action of the aquafortis, by reducing the quantity of the former of theſe metals to one fourth part of the whole maſs; which is done by ſufficiently increaſing the quantity of the ſilver, if it be neceſſary. This operation is called *quartation*, and is preparatory to the parting; and even many authors extend this name to the operation of parting. See the article PARTING.

QUARTER, the fourth part of any thing, the fractional expreſſion for which is $\frac{1}{4}$.

QUARTER, in weights, is generally uſed for the fourth part of an hundred weight avoirdupois, or 28 lb.

Uſed as the name of a dry meaſure, *quarter* is the fourth part of a ton in weight, or eight buſhels.

QUARTER, a term in the manege. To work from quarter to quarter, is to ride a horſe three times in upon the firſt of the four lines of a ſquare; then changing your hand, to ride him three times upon the ſecond: and ſo to the third and fourth; always changing hands, and obſerving the ſame order.

QUARTERS, with reſpect to the parts of a horſe, is uſed in various ſenſes: thus the ſhoulders and fore-legs are called the *fore-quarters*, and the hips and hinder-legs the *hind quarters*. The *quarters* of a horſe's foot are the ſides of the coffin, comprehending between the toe and the heel: the *inner* quarters are thoſe oppoſite to one another, facing from one foot to the other; and theſe are always weaker than the *outſide* quarters, which lie on the external ſides of the coffin. *Falſe quarters*, are a cleft in the horn of a horſe's hoof, extending from the coronet to the ſhoe. A horſe is ſaid to be *quarter-caſt*, when for any diſorder in the coffin we are obliged to cut one of the quarters of the hoof.

QUARTER, in aſtronomy, the fourth part of the moon's period: thus, from the new moon to the quadrature is the firſt quarter; from this to full moon, the ſecond quarter, &c.

QUARTER, in heraldry, is applied to the parts or members of the firſt diviſion of a coat that is quartered, or divided into four quarters. Quarter.

Franc QUARTER, in heraldry, is a quarter ſingle or alone; which is to poſſeſs one fourth part of the field. It makes one of the honourable ordinaries of a coat.

QUARTER of a Ship, that part of the ſhip's ſide which lies towards the ſtern; or which is comprehended between the aftmoſt end of the main chains and the ſides of the ſtern, where it is terminated by the quarter-pieces.

Although the lines by which the quarter and bow of a ſhip, with reſpect to her length, are only imaginary, yet experience appears ſufficiently to have aſcertained their limits: ſo that if we were to divide the ſhip's ſides into five equal portions, the names of each ſpace would be readily enough expreſſed. Thus the firſt, from the ſtern, would be the quarter; the ſecond, abaft the midſhips; the third, the midſhips; the fourth, before the midſhips; and the fifth, the bow. Whether theſe diviſions, which in reality are ſomewhat arbitrary, are altogether improper, may be readily diſcovered by referring to the mutual ſituation or approach of two adjacent veſſels. The enemy boarded us on the larboard ſide! Whereabouts? Abaft the midſhips, before the midſhips, &c.

Plate CCCCXXVII. n° 1. repreſents a geometrical elevation of a quarter of a 74 gun ſhip. A the keel, with *a* the falſe keel beneath it. B the ſtern-poſt. DD the quarter-gallery, with its balluſtrades and windows. EE the quarter-pieces, which limit and form the outlines of the ſtern. F the taffarel, or upper pieces of the ſtern. FG the profile of the ſtern, with its galleries. H the gun-ports of the lower-deck; *b* the gun-ports of the upper and quarter-deck. I the after-part of the mizen-channel. K the wing-tranſom. KG the lower counter. LB the ſtation of the deck-tranſom. LQ the after-part of the main-wale. DR the after-part of the channel-wale, parallel to the main-wale. SU the ſheer-rail, parallel to both wales. T *t* the rudder. A *t* F the rake of the ſtern. P *i i* the drift-rails. TU the after-part of the load *water-line*; *k k l* the curve of the ſeveral decks correſponding to thoſe repreſented in the head. See the article HEAD.

As the marks, by which veſſels of different conſtructions are diſtinguiſhed from each other, are generally more conſpicuous on the ſtern or quarter than any other part, we have repreſented ſome of the quarters, which aſſume the moſt different ſhapes, and form the greateſt contraſt with each other. N° 2. ſhows the ſtern and quarter of a Dutch flight. N° 3. the ſtern and quarter of a cat. N° 4. is the ſtern and quarter of a common galley. N° 5. exhibits the quarter of a firſt-rate galley, otherwiſe called a *galleaſſe*. N° 6. the quarter of a Dutch dogger, or galliot. N° 7. repreſents the ſtern and quarter of a ſloop of war.

The quarters of all other ſhips have a near affinity to thoſe above exhibited. Thus all ſhips of the line, and Eaſt-Indiamen, are formed with a quarter little differing from the principal figure in this plate. Xebecs have quarters nearly reſembling thoſe of galeaſſes, only ſomewhat higher. Hagboats and pinks approach the figure of *cats*, the former being a little broader in the ſtern, and the latter a little narrower; and the ſterns and quarters of cats ſeem to be derived from thoſe of fly-boats.

Quarter. boats. The ſterns of Dutch doggers and galliots are indeed ſingular, and like thoſe of no other modern veſſel: they have nevertheleſs a great reſemblance to the ſhips of the ancient Grecians, as repreſented in medals and other monuments of antiquity.

On the QUARTER, may be defined an arch of the horizon, contained between the line prolonged from the ſhip's ſtern and any diſtant object, as land, ſhips, &c. Thus if the ſhip's keel lies on an eaſt and weſt line, the ſtern being weſtward, any diſtant object perceived on the north-weſt or ſouth-weſt, is ſaid to be on the larboard or ſtarboard quarter.

QUARTER-Bill, a roll, or liſt, containing the different ſtations, to which all the officers and crew of the ſhip are quartered in the time of battle, and the names of all the perſons appointed to thoſe ſtations. See *QUARTERS*.

QUARTER-Maſter, is an officer, generally a lieutenant, whoſe principal buſineſs is to look after the quarters of the ſoldiers, their clothing, bread, ammunition, firing, &c. Every regiment of foot and artillery has a quarter-maſter, and every troop of horſe one, who are only warrant-officers, except in the Blues.

QUARTER-Maſter-General, is a conſiderable officer in the army; and ſhould be a man of great judgment and experience, and well ſkilled in geography. His duty is to mark the marches and encampments of an army: he ſhould know the country perfectly well, with its rivers, plains, marſhes, woods, mountains, defiles, paſſages, &c. even to the ſmalleſt brook. Prior to a march, he receives the order and route from the commanding general, and appoints a place for the quarter-maſters of the army to meet him next morning, with whom he marches to the next camp; where being come, and having viewed the ground, he marks out to the regimental quarter-maſters the ground allowed each regiment for their camp: he chooſes the head-quarters, and appoints the villages for the generals of the army's quarters: he appoints a proper place for the encampment of the train of artillery: he conducts foraging parties, as likewiſe the troops to cover them againſt aſſaults, and has a ſhare in regulating the winter-quarters and cantonments.

QUARTER-Netting, a ſort of net-work, extended along the rails on the upper part of a ſhip's quarter. In a ſhip of war theſe are always double, being ſupported by iron cranes, placed at proper diſtances. The interval is ſometimes filled with cork, or old ſails; but chiefly with the hammocks of the ſailors, ſo as to form a parapet to prevent the execution of the enemy's ſmall arms in battle.

Blackſtone's Comment. vol. iv. p. 271.

QUARTER-Seſſions, a general court held quarterly by the juſtices of peace of each county. This court is appointed by ſtat. 2 Hen. V. c. 4. to be in the firſt week after Michaelmas-day; the firſt week after the Epiphany; the firſt week after the cloſe of Eaſter; and in the week after the tranſlation of Saint Thomas a Becket, or the 7th of July. This court is held before two or more juſtices of the peace, one of whom muſt be of the *quorum*. The juriſdiction of this court by 34 Ed. III. c. 1. extends to the trying and determining of all felonies and treſpaſſes whatſoever, though they ſeldom, if ever, try any greater offence than ſmall felonies within the benefit of clergy, their commiſſion providing, that if any caſe of difficulty ariſes, they ſhall not proceed to judgment, but in the preſence of one of the juſtices of the courts of king's bench or common pleas, or one of the judges of aſſize. And therefore murderers and other capital felons are uſually remitted for a more ſolemn trial to the aſſizes. They cannot alſo try any new-created offence, without expreſs power given them by the ſtatute which creates it. But there are many offences, and particular matters, which by particular ſtatutes belong properly to this juriſdiction, and ought to be proſecuted in this court; as, the ſmaller miſdemeanors againſt the public or commonwealth, not amounting to felony, and eſpecially offences relating to the game, highways, alehouſes, baſtard children, the ſettlement and proviſion for the poor, vagrants, ſervants wages, apprentices, and popiſh recuſants. Some of theſe are proceeded upon by indictment, and others in a ſummary way by motion and order thereupon; which order may, for the moſt part, unleſs guarded againſt by particular ſtatutes, be removed into the court of king's bench, by writ of *certiorari facias*, and be there either quaſhed or confirmed. The records or rolls of the ſeſſions are committed to the cuſtody of a ſpecial officer, denominated the *cuſtos rotulorum*. In moſt corporation towns there are quarter-ſeſſions kept before juſtices of their own, within their reſpective limits, which have exactly the ſame authority as the general quarter-ſeſſions of the county, except in very few inſtances: one of the moſt conſiderable of which is the matter of appeals from orders of removal of the poor, which, though they be from the orders of corporation juſtices, muſt be to the ſeſſions of the county, by 8 and 9 Will. III. c. 30. In both corporations and counties at large, there is ſometimes kept a ſpecial or petty ſeſſion, by a few juſtices, for diſpatching ſmaller buſineſs in the neighbourhood between the times of the general ſeſſions, as for licenſing alehouſes, paſſing the accounts of pariſh-officers, and the like.

Quarter, Quarters.

QUARTER-Staff, a long ſtaff borne by foreſters, park-keepers, &c. as a badge of their office, and occaſionally uſed as a weapon.

QUARTERS, a name given at ſea to the ſeveral ſtations where the officers and crew of a ſhip of war are poſted in action. See *Naval* TACTICS.

The number of men appointed to manage the artillery is always in proportion to the nature of the guns, and the number and condition of the ſhip's crew. They are, in general, as follow, when the ſhip is well manned, ſo as to fight both ſides at once occaſionally:

Pounder.		No. of men.	Pounder.		No. of men.
To a 42	-	15	To a 9	-	6
32	-	13	6	-	5
24	-	11	4	-	4
18	-	9	3	-	3
12	-	7			

This number, to which is often added a boy to bring powder to every gun, may be occaſionally reduced, and the guns nevertheleſs well managed. The number of men appointed to the ſmall arms, on board his Majeſty's ſhips and ſloops of war, by order of the admiralty, are,

Quarters-
||
Quarto.

Rate of the ſhip.	No. of men to the ſmall arms.
1ſt - -	150
2d - -	120
3d of 80 guns -	100
— of 70 guns -	80
4th of 60 guns -	70
4th of 50 guns -	60
5th - -	50
6th - -	40
Sloops of war -	30

The lieutenants are uſually ſtationed to command the different batteries, and direct their efforts againſt the enemy. The maſter ſuperintends the movements of the ſhip, and whatever relates to the ſails. The boatſwain, and a ſufficient number of men, is ſtationed to repair the damaged rigging; and the gunner and carpenter, wherever neceſſary, according to their reſpective offices.

The marines are generally quartered on the poop and forecaſtle, or gang-way, under the direction of their officers; although, on ſome occaſions, they aſſiſt at the great guns, particularly in diſtant cannonading.

QUARTERS, at a ſiege, the encampment upon one of the moſt principal paſſages round a place beſieged, to prevent relief and convoys.

Head QUARTERS of an Army, the place where the commander in chief has his quarters. The quarters of generals of horſe are, if poſſible, in villages behind the right and left wings, and the generals of foot are often in the ſame place: but the commander in chief ſhould be near the centre of the army.

QUARTERS of Refreſhment, the place or places where troops that have been much haraſſed are put to recover themſelves during ſome part of the campaign.

Intrenched QUARTERS, a place fortified with a ditch and parapet to ſecure a body of troops.

Winter QUARTERS, ſometimes means the ſpace of time included between leaving the camp and taking the field; but more properly the places where the troops are quartered during the winter.

The firſt buſineſs, after the army is in winter-quarters, is to form the chain of troops to cover the quarters well: which is done either behind a river, under cover of a range of ſtrong poſts, or under the protection of fortified towns. Huſſars are very uſeful on this ſervice.

It ſhould be obſerved, as an invariable maxim, in winter-quarters, that your regiments be diſpoſed in brigades, to be always under the eye of a general officer; and, if poſſible, let the regiments be ſo diſtributed, as to be each under the command of its own chief.

QUARTERING, in heraldry, is dividing a coat into four or more quarters, or quarterings, by parting, couping, &c. that is, by perpendicular and horizontal lines, &c.

QUARTO-DECIMANS, an ancient ſect in the Chriſtian church, who taught that Eaſter ſhould always be celebrated according to the cuſtom of the Jews, on the fourteenth day of the moon in the month of March, whenſoever that day fell out. And hence they derived their name *quarto decimani*, q. d. Fourteenthers. The Aſiatics were mightily attached to this opinion, pretending that it was built on the authority of St John, who was their apoſtle; and pope Victor could never bring them to obedience in this article, though he was upon the point of excommunicating them: but it is more probable he contented himſelf with menaces. See EASTER. Quartz.

QUARTZ, a genus of ſiliceous earths very common in Europe. According to Kirwan, the quartz are in general the pureſt of the ſiliceous kind, though moſt of them contain a ſlight mixture of other earths: the moſt obvious diſtinction among them ariſes from their opacity or tranſparency. Cronſtedt gives the following characteriſtics of it: 1. It is generally cracked throughout, even in the rock itſelf, whereby, as well as by its own nature, it breaks into irregular and ſharp fragments. 2. It cannot be eaſily made red hot, without cracking ſtill more. 3. It never decays in the air. 4. Melted with fixed alkali in a due proportion, it gives a more ſolid and fixed glaſs than any of the other ſiliceous ſtones. 5. When there has been no interruption in its natural accretion, it always cryſtallizes into hexagonal priſms pointed at both ends. 6. It is met with in clefts, fiſſures, and ſmall veins in rocks; it ſeldom forms large veins, and ſtill more rarely whole mountains, without a mixture of heterogeneous ſubſtances. It is found,

1. Pure, of ſeveral varieties, as, (1.) Solid, or having no viſible particles, and called *fat quartz*. This is either tranſparent, white, blue, or violet-coloured. The firſt kind is met with in the copper-mines in the northern part of Norway and Siberia, and has no regular form, but is as clear as the fineſt cryſtallized quartz, or rock cryſtal. (2.) *Grained quartz*, of a white or pale green colour, found in various places in Sweden. (3.) The *ſparry quartz*, which is the ſcarceſt of the whole, and ought not to be confounded with the white felt-ſpar, becauſe it is of a ſmoother appearance, and breaks into larger and more irregular planes. It is found of a whitiſh yellow, from the gold mines in Hungary; or white, from the iſland of Uto. Brunnich tells us, that the Hungarian gold and ſilver mines near Hodentch, which have veins frequently ſome fathoms wide, afford a kind of lamellated and porous quartz. It is met with of white, yellow, and blue colours, and it is ſometimes finely cryſtallized in pyramidical figures.

2. *Cryſtallized quartz*, or *rock cryſtal*. See CRYSTAL.

3. *Impure quartz*. Of this there are two kinds, (1.) Mixed with iron, in form of a black calx. It is black, gloſſy, and contains a great quantity of iron. It is found in Sweden. (2.) Mixed with copper, and of a red colour, found in the ſame country.

Cronſtedt obſerves, that quartz in general, and eſpecially its cryſtals, are very commonly ſuppoſed, when yet in their ſoft and diſſolved ſtate, to have included within them ſome vegetables, for inſtance graſs and moſs. "This (ſays he) I cannot abſolutely deny; but it deſerves carefully to be examined if that which is ſhown as a graſs be not an aſbeſtos, or a ſtriated cockle; and the moſs only branched varieties filled with earth, which, by their being ramoſe, bear a vegetable appearance. It is very common in agates, and makes them of leſs value than they otherwiſe would be. This is moſt generally the caſe with thoſe ſtones which are ſhown as including vegetables; and, for my own part, I have

Quartz || Quaſi.

have never been ſo fortunate as to meet with any others."

M. Magellan remarks, that quartz is one of the principal kinds of ſtone which contain metals. Some of the Hungarian veins conſiſt entirely of it, and the gold is ſo minutely diſperſed, that it cannot be diſcerned by the beſt microſcopes before it is ſeparated by pounding and waſhing. The width of the veins, ſome of which are half a fathom, and ſome ſtill more, repay the trouble and expences, which the ſmall quantity of gold would not otherwiſe counterbalance. Nature has not anywhere produced mountains of pure quartz; for though ſome rocks in Sweden are ranked among the quartzes, they are undoubtedly mixed with heterogeneous matters. Near Lauterberg upon the Hartz are veins of this ſtone from one to three fathoms wide, conſiſting of a looſe ſand, in which they find the copper ore in neſts. In the Daniſh iſle of Anhalt we meet with triangular quartz pebbles. There are likewiſe cryſtals of quartz having water incloſed in them; ſome fine pieces of this kind are to be met with in the Imperial cabinet at Vienna, &c.

Rock cryſtals are generally found upon or among quartz, and are to be met with in all parts of the world. The greateſt number are furniſhed to the European countries from Mount Saint Gothard in Switzerland.—Here large pieces, weighing from 5 to 800 pounds, were found at Grimſelberg; one of 1200 pounds was found ſome years ago at Fiſbach in the Wallais; and a piece ſix feet long, four broad, and equally thick, was found in the iſland of Madagaſcar, a place where theſe natural productions are of the moſt extraordinary ſize and perfection.

When great quantities of quartz are continually agitated by the ſea or river water, they are ſometimes reduced to ſuch very minute parts as to be eaſily carried away, ſuſpended in the water; and there are ſands of ſo minute a ſize as to meaſure leſs than the two or three hundredth part of an inch. Theſe are called *quick-ſands*. Immenſe tracts of land conſiſt only of looſe ſands, particularly along the ſea-ſhore in many parts of Europe. Some ſuppoſe that ſea-water has the power of producing this ſand out of its own ſubſtance; and their ſurfaces, in general, are ſo poliſhed, as to ſhow that they could not be reduced in ſize by rubbing againſt each other; but we know not as yet that ſuch a production has ever been demonſtrated. When ſand is about as big as peas, it is called gravel; and when it is free from ſaline and heterogeneous particles, it is employed in making mortar, and other economical purpoſes. That which is very pure ſerves for making flint-glaſs, with red calces of lead, and the proper alkaline flux; but when mixed with ferruginous black ſand, the glaſs aſſumes a greeniſh black colour. "This (ſays M. Magellan) I have ſeen among the various ſpecimens of glaſs made by Mr E. Delaval, F. R. S. who produced a very fine tranſparent and colourleſs glaſs out of the ſame ſand with which he had made ſome of that black glaſs, and this only by ſeparating from it all the ferruginous mixture."

QUASHING, in law, the overthrowing and annulling a thing.

QUASI-CONTRACT, in the civil law, an act without the ſtrict form of a contract, but yet having the force thereof. In a contract there muſt be the mutual conſent of both parties, but in a *quaſi-contract* one party may be bound or obligated to the other, without having given his conſent to the act whereby he is obliged. For example: I have done your buſineſs, in your abſence, without your procuration, and it has ſucceeded to your advantage. I have then an action againſt you for the recovery of what I have diſburſed, and you an action againſt me to make me give an account of my adminiſtration, which amounts to a *quaſi-contract*.

Quaſi || Quaſſia.

QUASI-Crime, or *Quaſi-delict*, in the civil law, the action of a perſon who does damage, or evil, involuntarily. The reparation of *quaſi-crimes* conſiſts in making good the damages, with intereſt.

QUASS, a fermented liquor drunk in Ruſſia. See PEASANT.

QUASSIA, in botany: A genus of the monogynia order, belonging to the decandria claſs of plants; and in the natural method ranking under the 14th order, *Gruinales*. The calyx is pentaphyllous; there are five petals; the nectarium is pentaphyllous; there are from two to five ſeed-caſes ſtanding aſunder, and monoſpermous. There are three ſpecies, the *amara*, *ſimaruba*, and *excelſa* or *polygama*.

The quaſſia amara grows to the height of ſeveral feet, and ſends off many ſtrong branches. The wood is of a white colour and light; the bark is thin and grey: the leaves are placed alternately on the branches, and conſiſt of two pair of oppoſite pinnæ, with an odd one at the end: all the leafets are of an elliptical ſhape, entire, veined, ſmooth, pointed, ſeſſile, on the upper pagina of a deep green colour, on the under paler: the common footſtalk is articulated, and winged, or edged, on each ſide with a leafy membrane, which gradually expands towards the baſe of the pinnæ: the flowers are all hermaphrodite, of a bright red colour, and terminate the branches in long ſpikes: the bracteæ or floral leaves are lance-ſhaped or linear, coloured, and placed alternately upon the peduncles: the calyx is ſmall, perſiſtent, and five-toothed: the corolla conſiſts of five lance-ſhaped equal petals, at the baſe of which is placed the nectary, or five roundiſh, coloured, ſcales: the filaments are ten, ſlender, ſomewhat longer than the corolla, and crowned with ſimple antheræ, placed tranſverſely: the receptacle is fleſhy and orbicular: the germen is ovate, divided into five parts, and ſupports a ſlender ſtyle, longer than the filaments, and terminated by a tapering ſtigma: the capſules are five, two-celled, and contain globular ſeeds. It is a native of South America, particularly of Surinam, and alſo of ſome of the Weſt Indian iſlands. The root, bark, and wood, of this tree have all places in the materia medica. The wood is moſt generally uſed, and is ſaid to be a tonic, ſtomachic, antiſeptic, and febrifuge. *Woodville's Medical Botany*, vol. ii. p. 215.

The quaſſia ſimaruba is common in all the woodlands in Jamaica. It grows to a great height and conſiderable thickneſs. The trunks of the old trees are black and a little furrowed. Thoſe of the young trees are ſmooth and gray, with here and there a broad yellow ſpot. The inſide bark of the trunk and branches is white, fibrous, and tough. It taſtes ſlightly bitter. On cutting or ſtripping off this bark, no milky juice iſſues, as has been mentioned by various authors. The wood is hard, and uſeful for buildings. It ſplits freely, and makes excellent ſtaves for ſugar hogſheads. It has no ſenſible bitter taſte. The branches are alternate and ſpreading. The leaves are numerous and alternate. On the upper ſide, they are ſmooth, ſhining, and of a deep *Dr Wright's Paper, Edin. Tranſ.* vol. ii.

Quaſſia. deep green colour: on the under ſide they are white. The flowers appear about the beginning of April. They are of a yellow colour, and placed on ſpikes beautifully branched.

The fruit is of that kind called a *drupa*, and is ripe towards the end of May. It is of an oval ſhape, is black, ſmooth, and ſhining. The pulp is fleſhy and ſoft; the taſte a nauſeous ſweet. The nut is flattened, and on one ſide winged. The kernel is ſmall, flat, and taſtes ſweet. The natural number of theſe drupæ is five on each common receptacle; but, for the moſt part, there are only two or three; the reſt abort by various accidents. The roots are thick, and run ſuperficially under the ſurface of the ground to a conſiderable diſtance. The bark is rough, ſcaly, and warted. The inſide when freſh is a full yellow, but when dry paler. It has but little ſmell. The taſte is bitter, but not very diſagreeable. This is the true cortex ſimarubæ of the ſhops. This tree is known in Jamaica by the names of *mountain damſon*, *bitter damſon*, and *ſtave-wood*. The ſhops are ſupplied with this bark from Guiana; but now we may have it from our own iſlands at a moderate expence. On examining the fructification, Dr Wright found this tree to be a ſpecies of quaſſia. Under that name he ſent it to Europe, and Linnæus adopted it into his ſyſtem. There are male flowers on one tree and female flowers on another; and this is invariably the caſe in Jamaica.

Moſt authors who have written on the ſimaruba agree, that in fluxes it reſtores the loſt tone of the inteſtines, allays their ſpaſmodic motions, promotes the ſecretions by urine and perſpiration, removes that lowneſs of ſpirits attending dyſenteries, and diſpoſes the patient to ſleep; the gripes and teneſmus are taken off, and the ſtools are changed to their natural colour and conſiſtence. In a moderate doſe, it occaſions no diſturbance or uneaſineſs; but in a large doze it produces ſickneſs at ſtomach and vomiting. Negroes are leſs affected by it than white people. Dr Cullen, however, ſays, "We can perceive nothing in this bark but that of a ſimple bitter; the virtues aſcribed to it in dyſentery have not been confirmed by my experience, or that of the practitioners in this country; and leaving what others are ſaid to have experienced to be further examined and conſidered by practitioners, I can only at preſent ſay, that my account of the effect of bitters will perhaps explain the virtues aſcribed to ſimaruba. In dyſentery I have found an infuſion of chamomile flowers a more uſeful remedy." The quaſſia excelſa or polygama was named by Sir Joſeph Banks, Dr Solander, and Dr Wright, *pricrania amara*, (ſee *Pricrania Amara.*) It is ranked, however, by Mr John Lindſay, in a paper in the third volume of the Edinburgh Tranſactions, under *quaſſia*, who gives the following deſcription of it. "It is very common in the woodlands of Jamaica, is beautiful, tall, and ſtately, ſome of them being 100 feet long, and ten feet in circumference eight feet above the ground. The trunk is ſtraight, ſmooth, and tapering, ſending off its branches towards the top. The outſide bark is pretty ſmooth, of a light gray or aſh colour, from various lichens. The bark of the roots is of a yellow caſt, ſomewhat like the cortex ſimaruba. The inner bark is tough, and compoſed of fine flaxy fibres. The wood is of a yellow colour, tough, but not very hard. It takes a good poliſh, and is uſed as flooring. The leaves are ſub-alternate; the ſmall leaves are in pairs, from five to eight, ſtanding oppoſite to each other on ſhort footſtalks, and ending with an odd one. They are of an oblong oval ſhape, and pointed; the ribs reddiſh, and the young leaves are covered with a fine browniſh down. The flowers come out in bunches or cluſters from the lower part of the laſt ſhoot before the leaves, and ſtand on round footſtalks. The flowers are ſmall, of a yellowiſh green colour, with a very ſmall calyx. The male or barren tree has flowers nearly ſimilar to the hermaphrodite, but in it there are only the rudiments of a ſtyle.

Materia Medica, v. 1. ii. p. 75.

"The fruit is a ſmooth black drupa, round-ſhaped, and of the ſize of a pea. There is but little pulp, and the nut covers a round kernel. Theſe drupæ are generally three, ſometimes two, and often only one, attached ſidewiſe to a roundiſh fleſhy receptacle. It flowers in October and November, and its fruit is ripe in December and January. Except the pulp of the fruit, every other part of this tree has an intenſely bitter taſte. In taſte and virtues it is nearly equal to the quaſſia of Surinam, and I am credibly informed is ſold in London for the quaſſia amara; and it may be ſafely uſed in all caſes where that drug has been thought proper, whether as an antiſeptic, or in caſes of weakneſs in the ſtomach and bowels. It may either be given alone, or joined with the Jeſuit's bark. The happieſt effects reſult from the uſe of this medicine in obſtinate remitting fevers from marſh miaſmata, in agues which had reſiſted the uſe of Jeſuit's bark, and in dyſenteries of long ſtanding. It is in daily practice in dropſies from debility, either in ſimple infuſions or tincture by itſelf, or joined with aromatics and chalybeates. Dr Drummond, an eminent phyſician in Jamaica, preſcribes it with great ſucceſs in the above caſes, as well as in amenorrhæa, chloroſis, dyſpepſia, and in that ſpecies of pica called *dirteating*, ſo fatal to a number of negroes.

"The bark of the quaſſia polygama, but eſpecially the wood, is intenſely bitter. They may both be uſed in various forms. In certain caſes of dropſy, aromatics and preparations are joined to it, alſo in amenorrhæa and chloroſis; and in worm fevers, the cabbage-bark, or other vegetable anthelmintics."

Quaſſia ‖ Quebec.

QUATUORVIR, in antiquity, formerly written IIII. Vir, a Roman magiſtrate, who had three colleagues joined with him in the ſame adminiſtration, and had the care of conducting and ſettling the colonies ſent into the provinces. There were alſo quatuorviri appointed to inſpect and take care of repairs, &c.

QUAVER, in muſic, a meaſure of time equal to half a crotchet, or an eighth part of a ſemibreve.

QUAY. See Key.

QUEBEC, a handſome and large town of America, and capital of Canada. The firſt place taken notice of upon landing here is a ſquare of an irregular figure, with well-built houſes on each ſide; on the back of which is a rock; on the left it is bounded by a ſmall church; and on the right are two rows of houſes, parallel to each other. There is another between the church and the harbour; as alſo another long row on the ſide of the bay. This may be looked upon as a kind of ſuburb; and between this and the great ſtreet is a very ſteep aſcent, in which they have made ſteps for the foot-paſſengers to go up. This may be called

Quebec || Queen.

the *Upper Town*, wherein is the biſhop's palace; and between two large ſquares is a fort where the governor lodges. The Recolets have handſome houſes over-againſt it, and on the right is the cathedral church: over-againſt this is the Jeſuits college, and between them are well-built houſes; from the fort runs two ſtreets, which are croſſed by a third, and between theſe is a church and a convent. In the ſecond ſquare are two deſcents to the river of St Charles. The Hotel Dieu is in the midway; and from thence are ſmall houſes, which reach to the houſe of the intendant. On the other ſide of the Jeſuits college, where the church ſtands, is a pretty long ſtreet in which is a nunnery. Almoſt all the houſes are built of ſtone, and there are about 7000 inhabitants; the fort is a handſome building, but not quite finiſhed. Quebec is not regularly fortified: but it cannot be eaſily taken; for the harbour is flanked with two baſtions, which at high tides are almoſt level with the water. A little above one of the baſtions is a demi-baſtion, partly taken out of the rock; and above it, on the ſide of the gallery of the fort, is a battery of 25 pieces of cannon: ſtill above this is a ſquare fort called the *citadel*; and the ways from one fortification to another are difficult to paſs. To the left of the harbour, on the ſide of the road, there are large batteries of cannon, and ſome mortars; beſides theſe, there are ſeveral other fortifications not very eaſy to be deſcribed. In 1711 the Britiſh fitted out a fleet with a deſign to conquer Canada, which failed on account of the raſhneſs of the admiral; who, contrary to the advice of his pilot, went too near the Seven iſles, and ſo loſt his largeſt ſhips, and 3000 of his beſt ſoldiers. It is about 300 miles north-weſt of Boſton in New-England. On October 18. 1759, it was taken by the Britiſh under the command of General Wolfe, who loſt his life in the battle, after he had the ſatisfaction to know that our troops were victorious. Admiral Saunders commanded a ſquadron of men of war, and did immenſe ſervice in reducing this place; there being not a man in the navy but what was active on this occaſion, not excepting the ſailors belonging to the tranſport veſſels. After this valuable acquiſition, all Canada came under the juriſdiction of the crown of Great Britain. W. Long. 69. 48. N. Lat. 46. 55.

QUEDA, a kingdom of Aſia, in the peninſula beyond the Ganges, and near the ſtrait of Malacca. The king is tributary to Siam. The principal town is of the ſame name, and ſaid to contain about 8000 inhabitants; and is ſubject to the Dutch. It has a harbour, and is 300 miles north of Malacca. E. Long. 100. 5. N. Lat. 7. 5.

QUEDLINGBURG, a town of Germany, in the circle of Upper Saxony, and on the confines of the duchy of Brunſwick. Here is a famous abbey, whoſe abbeſs is a princeſs of the empire, and who ſends deputies to the diets. Her contingent is one horſeman and ten footmen. The inhabitants of the town live by brewing, huſbandry, and feeding of cattle. It is 10 miles ſouth-eaſt of Halberſtadt, and 32 weſt of Bernberg. E. Long. 11. 34. N. Lat. 52. 1.

QUEEN, a woman who holds a crown ſingly.

The title of *queen* is alſo given by way of courteſy to her that is married to a king, who is called by way of diſtinction *queen-conſort*; the former being termed *queen-regent*. The widow of a king is alſo called *queen*, but with the addition of *dowager*. See *Royal-Family*.

Queen || Queenborough.

Queen Charlotte's Sound, is ſituated at the northern extremity of the ſouthern iſland of New Zealand, near Cook's Strait, lying in 41. 6. of ſouth latitude, and 174. 19. of eaſt longitude. The climate of this ſound is much more mild than at Duſky Bay; and though there is not ſuch plenty of wild fowl and fiſh, the defect is ſufficiently compenſated by abundance of excellent vegetables. The hills about the ſound conſiſt moſtly of an argillaceous ſtone of a greeniſh grey, or bluiſh or yellowiſh brown colour. A green talkous or nephritic (by the jewellers called *jadde*) is likewiſe very common, together with horn-ſtone, ſhingle, ſeveral ſorts of flinty ſtones and pebbles, ſome looſe pieces of baſaltes, ſtrata of a compact mica or glimmer, with particles of quartz. Hence, Mr Forreſter thinks, there is reaſon to believe that this part of New Zealand contains iron-ore, and perhaps ſeveral other metallic ſubſtances. The country is not ſo ſteep as at Duſky Bay, and the hills near the ſea are generally inferior in height, but covered with foreſts equally intricate and impenetrable. Captain Cook ſowed the ſeeds of many vegetables in this place, that have uſeful and nutritive roots. He ſowed alſo corn of ſeveral ſorts, beans, kidney-beans, and peaſe. The dogs here are of the long-haired ſort, with pricked ears, and reſemble the common ſhepherd's cur, but they are very ſtupid animals. They are fed with fiſh, and even dogs fleſh, and perhaps human fleſh, which the natives alſo eat. Captains Cook and Furneaux left on theſe iſlands a boar and two ſows, with a pair of goats, male and female, with ſome geeſe, in order to benefit the natives and future generations of navigators. They left likewiſe among them a number of braſs medals guilt, on one ſide of which was the head of his preſent majeſty, with the inſcription George III. King of Great Britain, France, and Ireland, &c. On the reverſe, a repreſentation of two men of war, with the names Reſolution and Adventure over them; and the exergue, ſailed from England March MDCCLXXII.

Queen-Gold, is a royal duty or revenue belonging to every queen of England during her marriage to the king, payable by perſons in this kingdom and Ireland, on divers grants of the king by way of fine or oblation, &c. being one full tenth part above the entire fines, on pardons, contracts, or agreements, which becomes a real debt to the queen, by the name of *aurum reginæ*, upon the party's bare agreement with the king for his fine, and recording the ſame.

Queen's-County, a diviſion of the province of Leinſter in Ireland; ſo called from the popiſh Queen Mary, in whoſe reign it was firſt made a county by the earl of Suſſex, then lord-deputy. It is bounded on the ſouth by Kilkenny and Catherlogh; by King's county on the north and weſt; part of Kildare and Catherlogh on the eaſt; and part of Tipperary on the weſt. Its greateſt length from north to ſouth is 35 miles, and its breadth near as much; but it is unequal both ways. This county was anciently full of bogs and woods, though now pretty well incloſed, cultivated, and inhabited. The baronies contained in it are ſeven; and it ſends eight members to parliament.

Queen-Bee. See *Bee*, n° 3, &c.

QUEENBOROUGH, a town of the iſle of Shep-

Queensferry || Quercus.

pey in Kent, which ſends two members to parliament, though conſiſting only of about 100 low brick houſes, and ſcarce 350 inhabitants. The chief employment of the people here is oyſter drudging; oyſters being very plentiful, and of a fine flavour. E. Long. 0. 50. N. Lat. 51. 25.

QUEENS-FERRY, a town of Scotland, in the ſhire of Lothian, ſeated on the ſouth ſide of the river Forth, 9 miles weſt of Edinburgh.

Groſier's General Deſcription of China.

QUEI-LING-FOU, the capital of the province of Quangſi in China, has its name from a flower called *quei*, which grows on a tree reſembling a laurel; it exhales ſo ſweet and agreeable an odour, that the whole country around is perfumed with it. It is ſituated on the banks of a river, which throws itſelf into the Taho; but it flows with ſuch rapidity, and amidſt ſo narrow valleys, that it is neither navigable nor of any utility to commerce. This city is large, and the whole of it is built almoſt after the model of our ancient fortreſſes; but it is much inferior to the greater part of the capitals of the other provinces. A great number of birds are found in the territories belonging to it, the colours of which are ſo bright and variegated, that the artiſts of this country, in order to add to the luſtre of their ſilks, interweave with them ſome of their feathers, which have a ſplendor and beauty that cannot be imitated. Quei-ling has under its juriſdiction two cities of the ſecond claſs and ſeven of the third.

QUEI, in natural hiſtory, is a name given by the Chineſe to a peculiar earth found in many parts of the eaſt. It is of the nature of an indurated clay, and in ſome degree approaches to the talks, as our ſteatites and the galactites do. It is very white and abſterſive, uſed by the women of China to take off ſpots from the ſkin, and render it ſoft and ſmooth, as the Italian ladies uſe talk of Venice. They ſometimes uſe the fine powder of this ſtone dry, rubbing it on the hands and face after waſhing; ſometimes they mix it in pomatum.

QUERCI, a province of Guienne in France; bounded on the north by Limoſin, on the eaſt by Rouergue and Auvergne, on the ſouth by Upper Languedoc, and on the weſt by Agenois and Perigord. It is divided into Upper and Lower; and is fertile in corn, wine, and fruits. Cahors is the capital town.

QUERCUS, the OAK-TREE: A genus of the polyandria order, belonging to the monoecia claſs of plants; and in the natural method ranking under the 50th order, *Amentaceæ*. The calyx is nearly quinquefid; there is no corolla; the ſtamina are from five to ten in number. The female calyx is monophyllous, very entire, and ſcabrous. There is no corolla; the ſtyles are from two to five; and there is an ovate ſeed. See OAK.

Species. 1. The robur, or common Engliſh oak, grows from about 60 or 70 to 100 feet high, with a prodigious large trunk, and monſtrous ſpreading head; oblong leaves, broadeſt towards the top, the edges acutely ſinuated, having the angles obtuſe. There is a variety, having the leaves finely ſtriped with white. This ſpecies grows in great abundance all over England, in woods, foreſts, and hedge-rows; is naturally of an amazing large growth; there being accounts of ſome above 100 feet ſtature, with wonderful large trunks and ſpreading heads; and is ſuppoſed to continue its growth many centuries.

Quercus.

2. The prinus, or cheſnut-leaved American oak, grows 50 or 60 feet high; having large oblong-oval ſmooth leaves pointed both ways, the edges ſinuated-ſerrated, with the ſinuſes uniformly round.

3. The phellos, or willow-leaved American oak, grows 40 or 50 feet high, having long narrow ſmooth entire leaves, like thoſe of the willow. There is a variety called the *dwarf willow-leaved oak*.

4. The alba, or white Virginian oak, grows 30 or 40 feet high, having a whitiſh bark, with long obliquely-pinnatifid light-green leaves, the ſinuſes and angles obtuſe.

5. The nigra, or black Virginian oak, grows 30 or 40 feet high, having a dark-coloured bark, large wedge-ſhaped ſlightly-trilobated leaves.

6. The rubra, or red Virginian oak, grows about 60 feet high, having a dark-greyiſh bark, long obtuſely-ſinuated leaves, with the ſinuſes terminated by briſtly points, and have ſometimes red ſpotted veins, but generally dyeing in autumn to a reddiſh colour, remaining on the trees late in the ſeaſon.

7. The eſculus of Pliny, or cut-leaved Italian oak, grows about 30 feet high, having a purpliſh bark, oblong deeply-ſinuated ſmooth leaves, and long ſlender cloſe-ſitting acorns in very large cups.

8. Ægilops, or large prickly-cupped Spaniſh oak, grows 70 or 80 feet high or more, with a very large trunk, and widely-ſpreading head, having a whitiſh bark, large oblong-oval deeply-ſerrated ſmooth leaves, the ſerratures bowed backward, and large acorns placed in ſingularly large prickly cups. This is a noble ſpecies, almoſt equal in growth to our common Engliſh oak.

9. Cerris, or ſmaller prickly-cupped Spaniſh oak, grows 30 or 40 feet high, and has oblong lyre-ſhaped pinnatifid tranſverſely-jagged leaves, downy underneath, and ſmall acorns placed in prickly cups.

10. The ilex, or common evergeen oak, grows 40 or 50 feet high, having a ſmooth bark, oval and oblong undivided ſerrated petiolated leaves, downy and whitiſh underneath. The varieties are, broad-leaved, narrow-leaved, and ſometimes both ſorts and other different ſhaped leaves on the ſame tree, alſo ſometimes with ſawed and prickly leaves.

11. The gramuntia, or Montpelier holly-leaved evergreen oak, grows 40 or 50 feet high; and has oblong-oval, cloſe-ſitting ſinuated ſpinous leaves, downy underneath, bearing a reſemblance to the leaves of holly.

12. The ſuber, or cork-tree, grows 30 or 40 feet high, having a thick, rough, fungous, cleft bark, and oblong-oval undivided ſerrated leaves, downy underneath. This ſpecies furniſhes that uſeful material cork; it being the bark of the tree, which becoming of a thick fungous nature, under which, at the ſame time, is formed a new bark, and the old being detached for uſe, the tree ſtill lives, and the ſucceeding young bark becomes alſo of the ſame thick ſpongy nature in ſix or ſeven years, fit for barking, having likewiſe another freſh bark forming under it, becoming cork like the others in the like period of time; and in this manner theſe trees wonderfully furniſh the cork for our uſe, and of which is made the corks for bottles, bungs for barrels, and numerous other uſeful articles. The tree grows in great plenty in Spain and Portugal, and from theſe countries we receive the cork. The Spaniards

Quercus. burn it, to make that kind of light black we call Spaniſh black, uſed by painters. Cups made of cork are ſaid to be good for hectical perſons to drink out of. The Egyptians made coffins of cork; which being lined with a reſinous compoſition, preſerved dead bodies uncorrupted. The Spaniards line ſtone-walls with it, which not only renders them very warm, but corrects the moiſture of the air.

13. The coccifera, ſcarlet, or kermes oak, grows but 14 or 15 feet high, branching all the way, and of buſhy growth; with large oval, undivided, indented, ſpinous leaves; and producing ſmall glandular excreſcences, called *kermes* or *ſcarlet grain*, uſed by the dyers. The ſmall ſcarlet glands found in this tree, is the effect of certain inſects depoſiting their eggs betwixt the bark of the branches and leaves, cauſing an extravaſation of the ſap, and forming the excreſcence or ſubſtance in queſtion, which being dried is the kermes or ſcarlet paſtel.

14. The Molucca, Moluccan oak, commonly called *American live oak*, grows about 40 feet high, having oval, ſpear-ſhaped, ſmooth, entire leaves, and ſmall oblong eatable acorns.

All the above 14 ſpecies of quercus produce flowers annually in the ſpring, about April or May, of a yellowiſh colour, but make no ornamental appearance, and are males and females ſeparated in the ſame tree; the males being in looſe amentums, and the females ſitting cloſe to the buds in thick leathery hemiſpherical calyxes, ſucceeded by the fruit or acorns, which are oval nuts fixed by their baſe into rough permanent cups, and moſtly ſit quite cloſe, and ſome on ſhort footſtalks, ripening in autumn; which in the common Engliſh oak is in great abundance, and often in tolerable plenty on ſome of the other ſorts: thoſe of all the kinds ſerve for propagating their reſpective ſpecies; they are alſo excellent food for ſwine and deer, the common oak in particular.

Uſes, &c. Oak-trees, of all the above ſorts, may be employed in gardening to diverſify large ornamental plantations in out-grounds, and in forming clumps in ſpacious lawns, parks, and other extenſive opens; the evergreen kinds in particular have great merit for all ornamental purpoſes in gardens. But all the larger growing kinds, both deciduous and evergreens, demand eſteem principally as firſt-rate foreſt-trees for their timber. The Engliſh oak, however, claims precedence as a timber-tree, for its prodigious height and bulk, and ſuperior worth of its wood. Every poſſeſſor of conſiderable eſtates ought therefore to be particularly aſſiduous in raiſing woods of them, which is effected by ſowing the acorns either in a nurſery and the plants tranſplanted where they are to remain, or ſowed at once in the places where they are always to ſtand. All the ſorts will proſper in any middling ſoil and open ſituation, though in a loamy ſoil they are generally more proſperous: however, there are but few ſoils in which oaks will not grow; they will even thrive tolerably in gravelly, ſandy, and clayey land, as may be obſerved in many parts of this country of the common oak.

The oak is of the utmoſt importance to Britain, and its cultivation deſerves the utmoſt attention. Much, therefore, to the honour of the members of the *London Society for encouraging Arts Manufactures, and Commerce*, they have excited particular attention to it; and many excellent obſervations, drawn from practice, will be found in their Tranſactions. Quercus.

The propagation of the ſtriped-leaved varieties of the common oak, and any particular variety of the other ſpecies, muſt be effected by grafting, as they will not continue the ſame from ſeed: the grafting may be performed upon any kind of oakling-ſtocks raiſed from the acorns, and train them for ſtandards like the others.

The oak is remarkable for its ſlowneſs of growth, bulk, and longevity. It has been remarked that the trunk has attained to the ſize only of 14 inches in diameter, and of ſome to 20, in the ſpace of fourſcore years. As to bulk, we have an account of an oak belonging to Lord Powis, growing in Broomfield wood, near Ludlow in Shropſhire, in the year 1764, the trunk of which meaſured 68 feet in girth, 23 in length, and which, reckoning 90 feet for the larger branches, contained in the whole 1455 feet of timber, round meaſure, or 29 loads and five feet, at 50 feet to a load.

The Greendale oak, &c. we have already mentioned (ſee OAK). In the opinion of many, the Cowthorp oak near Wetherby in Yorkſhire is the father of the foreſt. Dr Hunter, in his edition of Evelyn, has given an engraving of it. Within three feet of the ſurface he ſays it meaſures 16 yards, and cloſe to the ground 26. In 1776, though in a ruinous condition, it was 85 feet high, and its principal limb extended 16 yards from the bole. The foliage was very thin. If this meaſurement were taken as the dimenſion of the *real ſtem*, the ſize of this tree would be enormous; but, like moſt very large trees, its ſtem is ſhort, ſpreading wide at the baſe, the roots riſing above the ground like buttreſſes to the trunk, which is ſimilar not to a cylinder but to the fruſtum of a cone. Mr Marſham ſays, "I found it in 1768, at four feet, 40 feet 6 inches; at five feet, 36 feet 6 inches; and at ſix feet, 32 feet 1 inch." In the principal dimenſions then, *the ſize of the ſtem*, it is exceeded by the Bentley oak; of which the ſame writer gives the following account: "In 1759 the oak in Holt-Foreſt, near Bentley, was at 7 feet 34 feet. There is a large excreſcence at 5 and 6 feet that would render the meaſure unfair. In 1778, this tree was increaſed half an inch in 19 years. It does not appear to be hollow, but by the trifling increaſe I conclude it not ſound." Theſe dimenſions, however, are exceeded by thoſe of the Boddington oak. It grows in a piece of rich graſs land, called the *Old Orchard Ground*, belonging to Boddington Manor-Farm, lying near the turnpike-road between Cheltenham and Tewkſbury, in the Vale of Glouceſter. The ſtem is remarkably collected at the root, the ſides of its trunk being much more upright than thoſe of large trees in general; and yet its circumference at the ground is about 20 paces: meaſuring with a two-foot rule, it is more than 18 yards. At three feet high it is 42 feet, and where ſmalleſt, *i. e.* from five to ſix feet high, it is 36 feet. At ſix feet it ſwells out larger, and forms an enormous head, which has been furniſhed with huge, and probably extenſive, arms. But time and the fury of the wind have robbed it of much of its grandeur; and the greateſt extent of arm in 1783 was eight yards from the ſtem.

In the Gentleman's Magazine for May 1794 we have an account of an oak tree growing in Penſhurſt park

Quercus

park in Kent, together with an engraving. It is called the *Bear* or *Bare oak*, from being ſuppoſed to reſemble that which Camden thought gave name to he county of Berkſhire. The tradition at Penſhurſt is that it is the very tree planted on the day that the celebrated Sir Philip Sydney was born. "Some late writers (ſays Mr Rawlet) have queſtioned this, and think that to have been a different tree, which was cut down ſome years ago, and was indeed much larger than this. I remember being once in the hollow of the preſent oak with the late Sir John Cullum; and his opinion then was, that its antiquity was greater than the period aſſigned. But, I aſſure you, the tradition of this place is conſtant for this tree; and, in confirmation of it, an old lady of 94 years of age, now living, has told me, that all the tenants uſed to furniſh themſelves with boughs from this tree, to ſtick in their hats, whenever they went to meet the earls of Leiceſter, as was always the cuſtom to do at the end of the park when they came to reſide at their ſeat here. This fine old oak ſtands upon a plain about 500 yards from their venerable manſion, near a large piece of water called *Lancut-well*. Ben Jonſon and Waller have particularly noticed it; and, from the diſtinguiſhed owners of this place, it may be truly ſaid to ſtand on claſſic ground. Within the hollow of it there is a ſeat, and it is capable of containing five or ſix perſons with eaſe. The bark round the entrance was ſo much grown up, that it has lately been cut away to facilitate the acceſs. The dimenſions of the tree are theſe:

	Feet.	Inches.
Girth cloſe to the ground - -	35	6
Ditto one foot from ditto -	27	6
Ditto five feet from ditto - -	24	0
Height taken by ſhadow -	73	0
Girth of loweſt, but not largeſt, limb	6	9

With reſpect to longevity, Linnæus gives account of an oak 260 years old: but we have had traditions of ſome in England (how far to be depended upon we know not) that have attained to more than double that age. Mr Marſham, in a letter to Thomas Beevor, Eſq; Bath Papers, Vol. I. p. 79, makes ſome very ingenious calculations on the age of trees, and concludes from the increaſe of the Bentley oak, &c. that the Fortworth cheſnut is 1100 years old.

Beſides the grand purpoſes to which the timber is applied in navigation and architecture, and the bark in tanning of leather, there are other uſes of leſs conſequence, to which the different parts of this tree have been referred. The Highlanders uſe the bark to dye their yarn of a brown colour, or, mixed with copperas, of a black colour. They call the oak *the king of all the trees in the foreſt*; and the herdſman would think himſelf and his flock unfortunate if he had not a ſtaff of it. The acorns are a good food to fatten ſwine and turkeys; and, after the ſevere winter of the year 1709, the poor people in France were miſerably conſtrained to eat them themſelves. There are, however, acorns produced from another ſpecies of oak, which are eaten to this day in Spain and Greece, with as much pleaſure as cheſnuts, without the dreadful compulſion of hunger.

Quercus Marina, the *Sea Oak*, in botany, the name of one of the broad-leaved dichotomous ſea-fucuſes. It is not agreed, among the late botaniſts, what was the ſea oak of Theophraſtus; and the moſt ancient botaniſts, Cluſius and Cæſalpinus, ſuppoſe it to have been a ſpecies of the ſhrubby coralline; but that ſeems by no means to have been the caſe, ſince Theophraſtus ſays his ſea oak had a long, thick, and fleſhy leaf; whence we may much more naturally conclude it to have been of the fucus claſs.

Queria ‖ Quevedo.

QUERIA, in botany: A genus of the trigynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 22d order, *Caryophillei*. The calyx is pentaphyllous; there is no corolla; the capſule is unilocular, and trivalved, with one ſeed. There are two ſpecies, *viz.* hiſpanica and canadenſis.

QUESNE (Abraham du), marquis of Queſne, admiral of the naval forces of France, and one of the greateſt men of the laſt age, was born in Normandy in 1610. He contributed to the defeating of the naval power of Spain before Gattari; was dangerouſly wounded before Barcelona in 1642, and on other occaſions: he went into the ſervice of the Swedes, and became vice-admiral; gave the Danes an entire defeat, killed their admiral, and took his ſhip. He was recalled into France in 1647, and commanded the ſquadron ſent to Naples. The ſea-affairs of France being much fallen, he fitted out divers ſhips for the relief of the royal army that blocked up Bourdeaux; which was the principal cauſe of the ſurrender of the town. He was very fortunate in the laſt wars of Sicily, where he beat the Dutch thrice, and De Ruyter was killed. He alſo obliged the Algerines to ſue for peace from France in a very humble manner. In ſhort, Aſia, Africa, and Europe, felt the effects of his valour. He was a Proteſtant; yet the king beſtowed on him the land of Bouchet, and to immortalize his memory gave it the name of that great man. He died in 1688.

QUESTION, in logic, a propoſition ſtated by way of interrogation.

QUESTION, or *Torture*. See RACK.

QUESTOR, or QUÆSTOR, in Roman antiquity, an officer who had the management of the public treaſure.

The queſtorſhip was the firſt office any perſon could bear in the commonwealth, and gave a right to ſit in the ſenate.

At firſt there were only two; but afterwards two others were created, to take care of the payment of the armies abroad, of ſelling the plunder, booty, &c. for which purpoſe they generally accompanied the conſuls in their expeditions; on which account they were called *peregrini*, as the firſt and principal two were called *urbani*.

The number of queſtors was afterwards greatly increaſed. They had the keeping of the decrees of the ſenate: and hence came the two officers of *queſtor principis*, or *auguſti*, ſometimes called *candidatus principis*, whoſe office reſembled in moſt reſpects that of our ſecretaries of ſtate; and the *queſtor palatii*, anſwering in a great meaſure to our lord-chancellor.

QUEUE, in heraldry, ſignifies the tail of a beaſt: thus, if a lion be borne with a forked tail, he is blazoned double-queued.

QUEVEDO de VILLEGAS (Franciſco), a celebrated Spaniſh poet, born at Madrid in 1570. He was deſcended from a noble family, and was made a knight of

Quick, Quicklime.

of St James; but was thrown into priſon by order of Count Olivarez, whoſe adminiſtration he ſatirized in his verſes, and was not ſet at liberty till after that miniſter's diſgrace. Quevedo wrote ſome heroic, lyric, and facetious poems. He alſo compoſed ſeveral treatiſes on religious ſubjects, and has tranſlated ſome authors into Spaniſh. He died in 1645. The moſt known of his works are, 1. The Spaniſh Parnaſſus. 2. The Adventurer Buſcon. 3. Viſions of Hell Reformed, &c. Quevedo was one of the greateſt ſcholars and moſt eminent poets of his time. His youth was ſpent in the ſervice of his country in Italy, where he diſtinguiſhed himſelf with the utmoſt ſagacity and prudence. His moral diſcourſes prove his ſound doctrine and religious ſentiments, while his literary pieces diſplay his infinite judgment and refined taſte. His great knowledge of Hebrew is apparent from the report of the hiſtorian Mariana to the king, requeſting that Quevedo might reviſe the new edition of the Bible of Arias Montanus. His tranſlations of Epictetus and Phocylides, with his imitations of Anacreon, and other Greek authors, ſhow how well he was verſed in that language: that he was a Latin ſcholar, his conſtant correſpondence, from the age of twenty, with Lipſius, Chifflet, and Scioppius, will ſufficiently illuſtrate. As a poet, he excelled both in the ſerious and burleſque ſtyle, and was ſingularly happy in that particular turn we have ſince admired in Butler and Swift. His library, which conſiſted of about five thouſand volumes, was reduced at his death to about two thouſand, and is preſerved in the convent of St Martin at Madrid.

QUICK, or *Quickset Hedge*, among gardeners, denote all live hedges, of whatever ſort of plants they are compoſed, to diſtinguiſh them from dead hedges; but in a more ſtrict ſenſe of the word, it is reſtrained to thoſe planted with the hawthorn, under which name thoſe young plants or ſets are ſold by the nurſery-gardeners who raiſe them for ſale. See the article HEDGES.

QUICKLIME, a general name for all calcareous ſubſtances when deprived of their fixed air; ſuch as chalk, limeſtone, oyſter-ſhells, &c. calcined. See CHEMISTRY, n° 511, 748, 837, and 914.

Quicklime has the following properties. 1. It is entirely ſoluble in water, with which it unites ſo rapidly as to occaſion conſiderable heat. When expoſed to air, it imbibes moiſture from thence. When united with as much water as is ſufficient to make it a fluid paſte, it is called *ſlaked lime*. Water ſaturated with quicklime is called *lime-water*. According to Brandt, lime-water contains about one part of quicklime to 700 or 800 parts of water. Slaked lime, or lime-water, being expoſed to the atmoſphere, attract from thence particles of fixable air which float in it, by which means the quicklime is rendered mild, inſoluble in water, and therefore appears on the ſurface of the lime-water, or of the ſlaked lime where this combination happens, in the ſtate of mild or combined calcareous earth, convertible by a ſecond calcination into quicklime, and is called *cream of lime*.

If the earth diſſolved in lime-water be precipitated from thence by any ſubſtance containing fixable air, as by mild alkalis or magneſia, it will unite with this air, become mild, and reſume its former weight and properties which it poſſeſſed before calcination. But if it be precipitated from the water by means of ſome ſubſtance which does not contain fixable air, but which is more ſtrongly diſpoſed than the earth to unite with the water, for inſtance, ſpirit of wine, the earth thus precipitated will be in the ſtate of quicklime, that is, cauſtic, and ſoluble in water. Quicklime

2. Quicklime unites with acids without effervеſcence, which is nothing elſe than an extrication of the fixable air, of which quicklime has been already deprived. It nevertheleſs ſaturates as much acid as it would have done if it had not been calcined.

3. Quicklime is more powerfully diſpoſed to unite with fixable air than fixed or volatile alkalis, or magneſia. Hence, when treated with theſe ſubſtances, it takes from them their fixable air, and is itſelf rendered mild, and reſtored to its original weight and properties. Thus two drams of chalk, having been by calcination reduced to one dram and eight grains of quicklime, were thrown into a filtrated ſolution of an ounce of mild fixed alkali in two ounces of water, and digeſted during ſome time; by which the calcareous earth became mild, and weighed one dram and 58 gr. By means of magneſia, the calcareous earth may be precipitated from lime-water; and this earth is found to be mild, and to have deprived the magneſia of its fixable air. By depriving alkalis of their fixable air, quicklime renders them more cauſtic and ſolvent, for the ſame reaſon that itſelf is by this privation of air rendered more cauſtic and powerfully ſolvent. This increaſe of cauſticity and diſſolving power is conſiſtent with a general rule, namely, that the more ſimple or leſs compounded any body is, that is, the leſs its general tendency to union is ſatisfied, the more diſpoſed it is to unite with or diſſolve other ſubſtances.

4. Quicklime has a diſpoſition to unite with ſulphur, with which it forms a hepar of ſulphur, ſimilar to that made by ſulphur united with an alkali, and, like this, ſoluble in water. It is alſo diſpoſed to unite with oils and with animal and vegetable matters, with reſpect to which it diſcovers a cauſtic and corroſive property.

5. Quicklime mixed with ſand forms a maſs which hardens, and is uſed as a cement or mortar.

All theſe properties of quicklime have been the objects of conſideration to the chemiſts and philoſophers; who have, as uſual, been divided in their opinions on the ſubject. The evident reſemblance of the action of quicklime to fire, has given occaſion for one party to derive all the active properties of this ſubſtance from fire; while, on the other hand, its want of heat, and incapacity of ſetting bodies on fire, unleſs by an acceſſion of water, were objections altogether inſurmountable. On the other hand, thoſe who denied the materiality of fire, and affirmed that it conſiſts only in a motion mechanically produced among the particles of bodies, were altogether at a loſs to ſhow a reaſon why this motion, or any thing reſembling it, ſhould continue perhaps for months after the exciting cauſe is taken away. To remove this difficulty, ſome have had recourſe to the action of a latent acid communicated to the quicklime by the fire; and which one chemiſt (Mr Meyer) has diſtinguiſhed by the name of *acidum pingue*. But on this hypotheſis it may be remarked in the firſt place, that the action of acids is as difficult to be explained as that of fire; and, in the ſecond place, that as all ſubſtances, by calcination into quicklime, loſe conſiderably of their weight,

Quicklime. weight, it ſeems very improbable that they ſhould acquire an acid or any other ſubſtance which could increaſe their weight. Beſides, from the experiments of Dr Black, it appears that the diminution of weight in calcareous ſubſtances is owing to their parting with a quantity of fixed air, the weight of which is much more conſiderable than that of any moiſture or fatty matter they contain. The loſs of this fixed air is now alſo univerſally allowed to be the reaſon of the cauſticity of the quicklime, as its ſuperior attraction for fixed air is looked upon to be the reaſon why it renders fixed and volatile alkalis cauſtic like itſelf. The only queſtion therefore can be, By what means are the calcareous earths deprived of their fixed air? To this queſtion the anſwer is evident, namely, that the action of the fire expels the fixed air; and if this is the caſe, it is evident, that to this action of fire, continued, the cauſtic properties of the lime are owing.

We come now to the diſcuſſion of the queſtion, Whether quicklime is to be conſidered as a pure earth, or a combination of it with ſomething elſe?—Moſt of the chemiſts, ſince the diſcovery of fixed air, have been inclined to think that quicklime is a pure earth uncombined with any thing elſe, and that it approaches more nearly to the ſtate of elementary earth than any other. But this opinion ſeems not to have a ſolid foundation; for there are other earths, ſuch as the baſis of alum, which, as far as they can be examined by us, are equally pure with quicklime, and yet diſcover not the ſmalleſt cauſticity, even after the moſt violent calcination. Beſides, from the property which quicklime has of depriving alkaline ſalts of their fixed air, we may learn, that there exiſts in it, when kept by itſelf, a certain principle which prevents it from abſorbing again the fixed air, with which it was once ſo cloſely united, except in certain circumſtances. It is well known, that fixed alkalis, as well as thoſe which are volatile, will abſorb fixed air from the common atmoſphere; and hence, tho' they are prepared in the moſt cauſtic ſtate, they will in a very ſhort time become mild by an expoſure to the atmoſphere; nay, it requires no ſmall degree of care to prevent the atmoſphere from having as much acceſs to them as is neceſſary to change them from a cauſtic to a mild ſtate. Now, as theſe ſubſtances thus attract the fixed air from the atmoſphere, it thence appears that the atmoſphere parts very readily with the fixed air which it contains. The quicklime, however, though it has a greater attraction for fixed air than the alkalis, yet does not become near ſo ſoon mild from expoſure to the air as the alkalis which have leſs attraction than itſelf. Hence the neceſſary inference muſt be, that quicklime, after being once calcined, inſtead of attracting, repels fixed air, unleſs it is placed in certain circumſtances, wherein the repelling power is deſtroyed, and the attractive power again manifeſts itſelf. Now it is manifeſt, that the power which originally repelled the fixed air was the action of fire; and conſequently, while the quicklime refuſes to attract fixed air, we muſt conclude that it is the ſame action which prevents the union. Quicklime therefore is not a pure earth, but a combination of a pure earth with fire; juſt as chalk, or limeſtone uncalcined, is not a pure earth, but a combination of a pure earth with fixed air. In all chemical trials, then, where quicklime is uſed, the double elective attraction will manifeſt itſelf as much as in a combination of different ſalts, metals, and acids. Thus Quicklime. when water is poured on quicklime, the attraction between that element and earth is ſtronger than the attraction between earth and fire. The conſequence is, that the water expels the fire, juſt as vitriolic acid poured upon ſea-ſalt expels the marine acid. The fire, then, having nothing with which it can form a chemical combination, becomes ſenſible to the touch, firſt making the lime very hot, and then gradually diſſipating in the atmoſphere. However, as the water combines with the earth but in very ſmall quantity, it can only expel the fire from that quantity with which it does combine; and conſequently the lime ſtill retains its cauſtic quality, though in a degree ſomewhat milder than what it was originally. We muſt alſo conſider, that water itſelf has a conſiderable attraction for fire as well as for earth; and the conſequence of this muſt be, that part of the lime will be diſſolved in the water, if more of that element is added than what the earth can abſorb without loſing the form of a dry powder. Hence the origin of lime-water, which is only a ſmall quantity of lime in its cauſtic ſtate diſſolved in a large quantity of water. This diſſolution is owing to the double attraction of fire to earth and water; for as long as the water can admit the calcined earth to that intimate union with itſelf which is called a *chemical combination*, the earth muſt ſtill retain all the cauſticity which the fire gives it, and diſſolve in the water. When the earth is in too large quantity to be thus combined with the water, the latter is only abſorbed into the pores of the earth, where by its bulk it ſplits the ſtone or calcined matter all to pieces, and reduces it to an impalpable powder, expelling a proportionable quantity of fire from thoſe pores which it now occupies. The water, however, is capable of radically diſſolving but a very ſmall portion of calcined earth: and therefore the ſame quantity of quicklime will ſerve for preparing lime-water a great number of times over; but at laſt a large quantity is left, which ſeems to be quite inert, and has loſt the properties of quicklime. Thoſe who have tried the experiment of lixiviating lime with freſh quantities of water till it ceaſes to be ſoluble, have fixed the proportion of ſoluble matter in the lime at about one-third of the whole; but from Dr Black's experiments it appears that quicklime may all be diſſolved in water at once, provided the water is in ſufficient quantity. Its inactivity, therefore, after repeated affuſions of water, muſt be owing to ſome change produced by the water; but whether this is owing to an abſorption of all the fire it contained by the great quantity of water, or to a ſupply of fixed air given by the water, has not yet been determined by any experiment.

If, inſtead of pouring cold water upon quicklime, we pour that which is already heated, the abſorption is much leſs complete; becauſe the water, having already a ſuperfluous quantity of heat, is reſiſted by that which is contained in the quicklime in a latent ſtate; and hence it is a general obſervation, that hot water is leſs proper for ſlaking lime than cold. But if we pour on any acid upon quicklime which contains a great quantity of fire in a latent ſtate, and has likewiſe a violent attraction for the earth, a much greater degree of heat is produced than with ſimple water. With the vitriolic acid, indeed, this is not ſo well perceived, if the common

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mon calcareous earths are made uſe of; becauſe their inſolubility in this acid diminiſhes its effect: but if, inſtead of theſe earths, we take magneſia newly calcined, the heat is ſo great, that the aqueous vapour, not having time to evaporate ſlowly, is driven off with a conſiderable exploſion. If the common calcareous earths, well calcined, are diſſolved in the nitrous acid, a moſt violent degree of heat is produced; more indeed than in any other caſe where a liquid is concerned: for the nitrous acid itſelf contains a great deal of latent heat; the quicklime does the ſame; and by the intimate union of the earth with the acid, all this latent heat, at leaſt a great part of it, both in the quicklime and ſpirit of nitre, is diſplaced, and attacks the aqueous fluid, as being neareſt to it; from whence it is diſſipated in the air, or abſorbed by the neighbouring ſubſtances. The ſame thing happens, only in a leſs degree, when the marine acid is employed.

When quicklime is mixed with a ſolution of mild alkali, a double decompoſition, and two new compoſitions, take place. The quicklime may be conſidered as a combination of earth and fire, while the alkali in the preſent caſe acts as a combination of ſalt and air. Theſe two ſubſtances, therefore, are no ſooner put into ſuch circumſtances as enable them to act on each other, than the quicklime attracts the air from the alkali, and gives its own fire in exchange, which the alkali takes up, and thus is rendered cauſtic, while the quicklime becomes mild. Nevertheleſs, though the alkali here ſeems to have the greater attraction for fire, and the quicklime for air; yet it appears that the alkali is by no means capable of keeping the fire which it has imbibed for any length of time: for no ſooner is it expoſed to the action of the air, than it parts with the fire which it had imbibed, regains its air, and becomes mild. This, however, in all probability is owing to its extreme ſolubility in water while in a cauſtic ſtate; for quicklime itſelf, when diſſolved in water, very eaſily regains its fixed air, nay, even more than it contains in a natural ſtate. See the article SALT.

On the whole, then, the properties of quicklime may be explained in a very eaſy manner on Dr Black's principle of latent heat. That heat conſiſts in a latent ſtate in quicklime, as well as in vapour, we have inconteſtable proofs; becauſe, in all caſes where quicklime changes its nature and becomes more mild, a degree of heat is produced, and which is always proportionable to the change made on the quicklime. In the making of quicklime, therefore, the air is expelled, and a proportional quantity of fire enters; in diſſolving it in an acid, ſlaking, &c. an acid, air, or water, expels part of the heat, which then becomes ſenſible. By long expoſure to the air, the heat gradually evaporates; the fixed air reſumes its place; and the quicklime being thus increaſed in bulk, embraces thoſe bodies very cloſely which lie neareſt to it; inſomuch that, when mixed with ſand and ſtones, it will harden with them almoſt into the ſolidity of a rock (ſee CEMENT and MORTAR). When mixed with animal or vegetable ſubſtances, it deſtroys or decompounds them, both by the action of its internal heat, and by its attraction for a certain acid contained in the animal ſubſtances, and an oily matter in the vegetables; and hence its property of burning cloth, though its attraction for the oily matter juſt mentioned makes it an excellent whitener when properly applied. See BLEACHING.

Quickſilver

QUICKSILVER, or MERCURY, one of the perfect metals, and ſo fuſible that it cannot be reduced to a ſolid ſtate but by the moſt intenſe degree of cold, ſcarcely, if at all, under 40° below 0 of Fahrenheit's thermometer. See CONGELATION. For the method of extracting quickſilver from its ore, &c. ſee METALLURGY, p. 454, and 475. For the various preparations, &c. from it, ſee CHEMISTRY *Index* at *mercury* and *quickſilver*, and PHARMACY *Index* at *mercury* and *quickſilver*. And for its uſe in medicine, ſee MEDICINE, n° 350, and MERCURY.

It is found, 1. Native, as in the mines of India, Friuli, Lower Auſtria, Deux Ponts, &c. flowing through beds of ſtone, and collecting in the clifts or cavities of rocks. In theſe mines, however, Mr Kirwan is of opinion that it is mixed with ſome other metal, as the globules into which it is divided are not perfectly ſpherical. In Sweden and Germany it has been found united to ſilver in form of a hard and ſomewhat brittle amalgam. It has alſo been obſerved viſibly diffuſed through maſſes of clay or ſtone, of a white, red, or blue colour, and very heavy in Spain and Idria; and in Sicily in beds of chalk.

Mines of quickſilver, however, are very rare, inſomuch that, according to the calculations of Hoffman, there is 50 times more gold got every year out of the mines than mercury and its ores. But Dr Lewis, in his notes upon Newmann, ſays, that Cramer ſuſpects that Hoffman only meant five times inſtead of 50; but neither the Latin nor the Engliſh edition of this author expreſſes any ſuch thought; on the contrary, he adopts the ſame opinion; and only adds, that mercury is much more frequently met with than is commonly believed; but being ſo volatile in the fire, it often flies off in the roaſting of ores, and eſcapes the attention of metallurgiſts.

According to Newmann, the mines of Idria have produced at the rate of 231,778 pounds weight of mercury *per annum*; but thoſe of Almaden in Spain produce much more. The chemiſts of Dijon inform us, that their annual produce is five or ſix thouſand quintals, or between five and ſix hundred thouſand pounds weight. In the year 1717 there were upwards of 2,500,000 pounds of quickſilver ſent from them to Mexico, for the amalgamation of the gold and ſilver ores of that country.

At Guacanvelica in Braſil the annual produce of the mines, according to Bomare, amounts to one million of pounds, which are carried overland to Lima, thence to Arica, and laſtly to Potoſi for the ſame purpoſe.

Beſides theſe mines there are others in Braſil near Villa Rica, where ſuch a quantity of cinnabar and native running mercury are found near the ſurface of the earth, that the black ſlaves often collect it in good quantities, and ſell it for a trifling price to the apothecaries; but none of theſe mines have ever been worked or taken notice of by the owners. Gold naturally amalgamated with mercury is likewiſe met with in the neighbourhood of that place; and it is ſaid that almoſt all the gold mines of that country are worked out by ſimply waſhing them out with running water, after reducing into powder the hard ores, which are ſometimes imbedded in quartzoſe and rocky matrices.

In the duchy of Deux Ponts and in the Lower Auſtria

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ſtria the quickſilver flows from a ſchiſtoſe or ſtony matrice, and is probably, ſays Mr Kirwan, mixed with ſome other metal, as its globules are not perfectly ſpherical. The mines of Friuli are all in ſimilar beds or ſtrata. The metal is likewiſe found viſibly diffuſed through maſſes of clay or very heavy ſtone, of a white, red, or blue colour; of which laſt kind are the mines of Spain, ſome of Idria, and of Sicily. Maſcagni found fluid quickſilver, as well as native cinnabar and mineral ethiops, near the lake of Travale in the duchy of Sienna; but the quantity was ſo ſmall as not to be worth the expence of working. On the other hand, the following mines afford profits to the owners after clearing all expences, viz. thoſe at Kremnitz in Hungary; at Horowitz in Bohemia; Zorge in Saxony; Wolfſteim, Stahlberg, and Moeſchfeld in the Palatinate. Mercury is alſo brought from Japan in the Eaſt Indies; but the greateſt part of what is ſold in Europe as Japan cinnabar is ſaid to be manufactured in Holland.

Lemery, Pomet, and others, lay down ſome external marks by which we may diſtinguiſh thoſe places where there are mines of quickſilver, viz. thick vapours like clouds ariſing in the months of April and May; the plants being much larger and greener than in other places: the trees ſeldom bearing flowers or fruit, and putting forth their leaves more ſlowly than in other places; but, according to Neumann, theſe marks are far from being certain. They are not met with in all places where there is quickſilver, and are obſerved in places where there is none. Abundance of theſe cloudy exhalations are met with in the Hartz foreſt in Germany, though no mercury has ever been found there; to which we may add, that though vaſt quantities of mercurial ores are found at Almaden in Spain, none of the above-mentioned indications are there to be met with.

Native mercury was formerly ſought from the mines of Idria with great avidity by the alchemiſts for the purpoſe of making gold; and others have ſhowed as ridiculous an attachment to the Hungarian cinnabar, ſuppoſing it to be impregnated with gold; nay, we are informed by Neumann, that not only the cinnabar, antimony, and copper of Hungary, but even the vine trees of that country were thought to be impregnated with the precious metal. Not many years ago a French chemiſt adverti ſed that he had obtained a conſiderable quantity of gold from the aſhes of vine twigs and ſtems, as well as of the garden ſoil where they grew; but the falſehood of theſe aſſertions was demonſtrated by the count de Lauragais to the ſatisfaction of the Royal Academy of Sciences.

The reduction of mercury into a ſolid ſtate, ſo that it might be employed like ſilver, was another favourite alchemical purſuit. But all proceſſes and operations of this kind, ſays Neumann, if they have mercury in them, are no other than hard amalgams. When melted lead or tin are juſt becoming conſiſtent after fuſion, if a ſtick be thruſt into the metal, and the hole filled with quickſilver, as ſoon as the whole is cold, the mercury is found ſolid. Macquer informs us, that mercury becomes equally ſolid by being expoſed to the fumes of lead. Maurice Hoffman, as quoted by Neumann, even gives a proceſs for reducing mercury, thus coagulated, to a ſtate of malleability, viz. by repeatedly melting and quenching it in linſeed oil. Thus, he tells us, we obtain a metal which can be formed into rings and other utenſils. But here the mercury is entirely diſſipated by the repeated fuſions, and nothing but the original lead is left. Wallerius, after mentioning ſtrong ſoap-leys, or cauſtic lixivium, and ſome other liquors proper for fixing quickſilver, tells us, that by means of a certain gradatory water, the compoſition of which he learned from Creuling *de Aureo Vellere*, he could make a coagulum of mercury whenever he pleaſed, of ſuch conſiſtency that great part of it would reſiſt cupellation; but what this gradatory water was, he has not thought proper to lay before the public.

2. Native precipitate *per ſe*, in which the metal is mineralized by aerial acid. This was lately found in Idria, in hard compact maſſes of a browniſh red colour and granular texture, mixed with ſome globules of native mercury. An hundred parts of it afford 91 of running mercury.

Various little globules of mercury were contained in this ore, which are rendered very viſible by being heated, but are ſoon reabſorbed by cooling. On expoſing it to the fire in an iron ſpoon, the red colour ſoon became more vivid, but turned yellowiſh on cooling. Diſtilled in a pneumonic apparatus, a quantity of dephlogiſticated air was produced, though leſs by one fourth than what ſhould have been produced by an equal quantity of cinnabar. On diſtilling an ounce of this ore in a glaſs retort, a little yellow powder was left, which weighed a fourth part of a grain, and ſtained the bottom of the retort in a manner ſimilar to what is done by the calx of ſilver to white glaſs in ſimilar circumſtances. On cupelling this powder with 144 grains of lead wrapped up in paper, the increaſed weight of the lead over that of the teſt of compariſon ſhowed that the calx was reduced into its metallic ſtate of ſilver and mixed with that of lead.

3. Mineraliſed by the vitriolic and marine acids. This kind of ore was firſt diſcovered in the year 1776, at Obermoſchal in the duchy of Deux Ponts. It has a ſpar-like appearance, and is either bright and white, or yellow or black, and mixed with cinnabar in a ſtony matrix. The native marine ſalt of mercury is in the ſtate of corroſive ſublimate.

4. Native cinnabar, in which the metal is mineraliſed by ſulphur. This is of different ſhades from a yellowiſh to a deep red; and is found either pure in hard friable maſſes, either ſhapeleſs or cryſtallized in cubes, and ſometimes tranſparent, or intermixed with clay or ſtone, or interſperſed through the ores of other metals, particularly thoſe of ſilver, copper, or martial pyrites. Its texture is either radiated, ſtriated, ſcaly, or granular. An hundred parts of cinnabar contain about 80 of mercury and 20 of ſulphur; but artificial cinnabar contains a little more ſulphur, and hence its colour is darker. Its ſpecific gravity is about 7.000; it ſublimes in cloſe veſſels, and is decompoſed and volatilized in open ones. It is found in the duchy of Deux Ponts, in the Palatinate, in Hungary, Friuli, and Almaden in Spain, and in South America, eſpecially at Guancavelica in Peru. It is ſometimes compact, and ſometimes found in tranſparent, ruby-coloured cryſtals, and often in a kind of ſcales or flattened laminæ. It is called native vermilion, and cinnabar in flowers, when it is in the form of a very bright red powder. It is alſo found in different earths, in ſelenite mixed with iron, with pyrites,

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and with ſulphur. Mr Fourcroy enumerates the following varieties: 1. Tranſparent cinnabar, red and cryſtallized in very ſhort triangular priſms, terminated by triangular pyramids. 2. Tranſparent red cinnabar, in octohedral cryſtals, conſiſting of two triangular pyramids united at their baſes and truncated. 3. Solid compact cinnabar, of a brown or bright red; it is ſometimes foliated. 4. Red cinnabar diſtributed in ſtriæ, on a ſtony matrix, or on ſolid cinnabar. It is ſometimes compoſed of needles like cobalt. 5. Cinnabar in flowers, or native vermilion. It is of a bright red colour, and ſattin appearance, adhering to different matrices, in form of a very fine powder. It is ſometimes cryſtallized in very ſmall needles, and then greatly reſembles the foregoing.

The finer coloured ores of mercury are never worked for extracting the metal, but uſed entirely as pigments; but they have been very injudiciouſly preferred for medicinal uſes to the more pure factitious cinnabars; for we ſeldom meet with any native cinnabar that has not ſome earthy or ſtony matter intermixed with it, nor with two pieces that perfectly agree. There are three varieties principally diſtinguiſhed in the ſhops; viz. 1. Cinnabar in maſſes weighing from one to ſix ounces or more. 2. In grains, prepared by breaking the worſe coloured maſſes, and picking out the beſt coloured bits. 3. Waſhed cinnabar, prepared by waſhing over the lighter impurities that are to be found in it. No native cinnabar ſhould ever be employed in medicine without being previouſly purified by ſublimation. Neumann informs us that he never met with any native cinnabar which did not leave a grey aſh or ſand, amounting, among different parcels, from one ninth to one fifth of the mineral employed. The reſiduum had no gold in it, though the colour of its ſolution and precipitate gave ſome expectation of it at firſt ſight.

Neumann remarks, that though vitriolic acid forms with mercury a lively yellow concrete, viz. turbith mineral, and with the inflammable principle a yellow ſulphur; and though ſulphur itſelf forms with mercury a beautiful red cinnabar; yet the ſame vitriolic acid deſtroys the red colour entirely, rendering it as white as milk. This change is not immediately produced on common cinnabar by the vitriolic acid; but, on being digeſted over a ſtrong ſand heat in a glaſs cup, it ſoon becomes as white as cream; and the vitriolic acid takes the form of a ſtrong ſulphureous and volatile vapour, very ſuffocating and corroſive; emitting very piercing fumes for ſome time, which turned the paper that covered it black, and deſtroyed its texture.

5. Black ore of mercury, in which the metal is mineralized by ſulphur and copper. This is of a blackiſh grey colour, a glaſſy texture, brittle, heavy, and decrepitating ſtrongly when heated. It is found at Muſchel Lanſberg. An ore of this kind is alſo found in the duchy of Deux Ponts. In the ſulphur of Idria a black cinnabar is likewiſe ſaid to be found, which retains its colour in ſublimation; but this is not yet ſufficiently confirmed, though it is too bold an aſſertion of Dr J. R. Forſter that no ſuch cinnabar has ever been found. He adds, that a certain learned man thought he had diſcovered ſome near the copper ores at Lauterberg; but that it proved to be a red copper calx, which is ſtill to be met with in that place.

6. Pyritous mercurial ore was brought from Dauphiny by Mr Montigny in 1768. It is grey, whitiſh, and friable. An hundred parts yielded one of mercury, one half of ſilver, the remainder being iron, cobalt, ſulphur, and arſenic. Quick-ſilver.

7. An ore of mercury, in which the metal is mineralized with iron by ſulphur, is mentioned by Sir Torbern Bergman in his *Sciagraphia*, ſect. 177. He ſays that it is doubtful whether this does not belong to the ſpecies of cinnabar, as the iron is perhaps only mechanically diffuſed thereon. Mr Mongez informs us, that there are but few inſtances of cinnabar in which iron is not found in its calcined form, though, in the act of the ore being reduced, it paſſes to its metallic ſtate, and becomes capable of being acted upon by the loadſtone.

Another pyritous ore of cinnabar was found at Menidot, near St Lo in Lower Normandy. It conſiſted of differently ſized grains of a red brown colour: they had a vitriolic taſte and ſulphureous ſmell. Pyritous ores of this kind are likewiſe found at Almaden in Spain, and at Stahlberg in the Palatinate. The cinnabaric pyrites of this laſt place are of a dodecaedral form.

8. Mr Gellert informs us, that an ore of quickſilver is met with in Idria, where the mercury lies in an earth or ſtone, as if it were in a dead form; and has the appearance of a red-brown iron-ſtone, but much heavier. It contains from three quarters to ſeven-eighths of the pureſt mercury, leaving after diſtillation a very black ſtrong earth, giving alſo ſome marks of cinnabar. For, as we do not know the ultimate diviſibility of mercury, we cannot juſtly determine the point of its fluidity, although its globules may be no more diſcernible.

The *liver-ore*, which is moſt common in Idria, and has its name from its colour, reſembles an indurated iron-clay; but its weight diſcovers it to have metallic contents. An hundred weight of it ſometimes yields 80 pounds of quickſilver.

The *brand-erz*, or burning ore of the Germans, likewiſe belongs to this ſpecies. It may be lighted at a candle, and yields from 9 to 50 pounds of metal in the 100.

9. Dr Gmelin informs us, that cinnabar mixed with arſenic or realgar is ſaid to be found in Japan; and that at Morsfield the cinnabar and white calx of arſenic preſent themſelves in the ſame rock.

10. Beſides the ores already mentioned, we ſometimes meet with quickſilver natively amalgamated with gold, ſilver, and other metals. This is taken notice of by Bergman; and from the authorities of Monet and Prof. Gmelin, Mr Kirwan informs us, that in Sweden and Germany this metal has been found united to ſilver in an hard and brittle amalgam. M. de L'Iſle had a ſpecimen of this ore from Germany; which, as M. Mongez informs us, is imbedded in a quartzoſe maſs, and mixed with cinnabar. A ſpecimen brought from the mine called *Carolina*, in a cryſtalline form, was depoſited in the royal cabinet at the king's garden at Paris. M. de L'Iſle likewiſe informs us, that a ſpecimen of native gold was brought from Hungary, which, according to Cronſtedt, was probably an amalgam of mercury and gold. It is compoſed of quadrangular priſms, of a greyiſh yellow colour, and brittle texture. Neumann likewiſe obſerves, that ſometimes a mineral, containing

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containing gold or ſilver, is met with among mercurial ores, though very rarely.

Theſe natural amalgams account for the great ſpecific gravity of ſome kinds of quickſilver. This may proceed from a natural mixture of gold, though, according to Boerhaave, it may alſo ariſe from its being rediſtilled a great number of times. By a ſimilar mode of reaſoning we may conclude, that the ſmalleſt ſpecific gravities of quickſilver proceed from its amalgamation with ſilver, lead, and other metals or ſemimetals, which in ſpite of repeated diſtillations may ſtill preſerve their union with it; for Dr Boerhaave informs us that he could not, by any number of diſtillations, free mercury perfectly either from tin or lead.

M. Magellan, in his notes on Cronſtedt's Mineralogy, ſays, "That mercury is many times found amalgamated with lead, is eaſily evinced by the proceſs of M. Groſſe mentioned by Macquer in his elements of Chemiſtry, where the method of extracting mercury from ſome ſolutions of lead is deſcribed; but the ſame Macquer, in his Chemical Dictionary, poſitively affirms, that, though Beccher and Kunckel have both given other proceſſes for extracting mercury from lead, and though the method pointed out by M. Groſſe is eaſier than the others, nevertheleſs it does not ſucceed if the lead be quite pure without any amalgamation with mercury. And Boerhaave has expreſsly made the ſame aſſertion, complaining of thoſe authors who affirm the contrary." Dr Black, however, ſeems to be of a different opinion; and, in his public courſe of lectures, teaches that, "by ſome proceſſes of the more difficult kind, mercury may be extracted from lead;" though he cautions us, at the ſame time, not to infer from this, or any other chemical proceſs, the poſſibility of the tranſmutation of metals.

Mercury is not in any way altered by the action of light. Its dilatation by heat is extremely regular, as has lately been ſhown, in a very great variety of experiments, by Dr Adair Crawford; for which reaſon it is uſed as the meaſure of heat, and thermometers are uſually filled with this metal. When oppoſed to the heat of about 600° of Fahrenheit, it boils and is diſperſed in an inviſible fume; which, however, has been obſerved to have the elaſticity of the ſteam of water, and to burſt an iron box in which it was attempted to confine it. If it be made to boil in a cloſe veſſel fitted with a proper apparatus, it will all come over in its proper form, and leave any fixed matter it might contain in the retort. This affords an eaſy method of purifying it from the baſe metals with which it is frequently adulterated; though even in this way it is neceſſary to raiſe the fire cautiouſly, or a part of the fixed metal will be carried up along with the mercury. And even with all the care that can be taken, it has been found impoſſible, as has been already ſaid, to free it perfectly from a mixture of the baſe metals by any number of diſtillations.

By a very great number of diſtillations, however, it was ſaid that ſome change might be made upon this metal; and that it became not only purer, but ſpecifically *heavier*, by ſuch an operation. Boerhaave, after making it undergo this operation 511 times, found ſome difference; but three years after, in a Memoir inſerted in the Philoſophical Tranſactions for 1736, he acknowledged, that, on repeating the operation 877 times, its ſpecific gravity, as ſhown by Dr Graveſande's nice hydroſtatic balance, appeared to be no more than 13.500 to diſtilled water.

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"Boerhaave died (ſays Mr Magellan in his Notes on Cronſtedt's Mineralogy) two years after, on the 23d of September 1738; and left his papers to his two nephews, Herman, who died the 7th of October 1753, and Kaw, who died five years after. On their deaths the manuſcripts fell into the hands of Charles Frederick Kruſe phyſician to the Emperor-of Ruſſia. This gentleman publiſhed a ſhort extract from Boerhaave's Diary in the ninth volume of the *Novi Commentarii* of the Imperial Academy of Peterſburg, of which the following are the reſults.

"The ſpecific gravity of the pureſt gold to that of diſtilled water is - - 19,024

That of mercury diſtilled once in a retort	13,570
Diſtilled 1009 times - -	13,590
Once from its amalgam with gold -	13,550
750 times from the ſame amalgam -	13,520
877 times from the ſame - -	13,500
Once from its amalgam with ſilver -	13,550
217 times from the ſame amalgam -	13,500

"It is evident, therefore, by theſe facts, that mercury does not acquire any additional increaſe to its ſpecific gravity by the mere repetition of ſimple diſtillations, nor by its amalgamations with gold or ſilver, provided it be afterwards properly ſeparated by fire."

It is certain, however, that there are very conſiderable differences in the ſpecific gravity of different ſpecimens of quickſilver; and authors have by no means agreed in fixing the ſtandard.—Bergman ſtates it at 14.110; and Muſchenbroek aſſerts that ſuch was the ſpecific gravity of Boerhaave's quickſilver that had been diſtilled 511 times: but ſome modern authors, among whom is M. Fourcroy, ſtate the ſpecific gravity of this metal at no more than 13.000. Modern experiments, however, ſhow that it is generally about 13.500 or 13.600. "This (ſays Mr Magellan) I am informed was the mean ſpecific gravity found by the late Lord Cavendiſh, after the repeated and nice trials he made upon 50 different ſpecimens of quickſilver, on which he employed all his induſtry and attention to determine this point.

"The hydroſtatical experiments I lately undertook of this kind upon ten different ſpecimens of mercury, two of which were revived from natural and artificial cinnabar by the operator of Mr Kirwan, confirmed me in the ſame opinion.

"The temperature of the atmoſphere was nearly the mean, viz. at the 50th degree of Fahrenheit's thermometer; and the ſcales employed were ſo nice, that they turned with the hundredth part of a grain when loaded with four pounds weight.—The method made uſe of to aſcertain theſe ſpecific gravities is the eaſieſt of all. A phial of white glaſs with a ground ſtopple was counterbalanced with lead or other matter in a nice pair of ſcales. The ſubſtance to be tried was introduced into the phial and weighed together, and the weight we ſuppoſe $= a$. The remaining ſpace of the phial being then filled with diſtilled water, we ſuppoſe the weight now to be $= b$. Laſtly, the phial was filled with diſtilled water, and the weight ſuppoſed $= c$. It is evi-

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dent, that $b - a = d$, the quantity of water in the second operation; $c - d = e$, the water whose bulk is equal to that of the substance; and that $\frac{a}{e}$ is the specific gravity sought for.—Particular care was taken that no bubble of air remained in the inside. For this purpose a very small groove was made with a file on the inside of the glass stopper; and this was introduced sidewise without admitting any air, leaving the superfluous water to rush out.

"The greatest specific gravity of any of those specimens was 13.620, and the least 13.450. The heaviest was neither of the two that had been distilled from cinnabar, but a common quicksilver bought at Apothecaries Hall, London; and the lightest was taken from a barometer of the best and dearest kind made by one of the most reputed instrument-makers in England.

"The most obvious cause of this difference of specific gravity in quicksilver seems to be its mixture or amalgamation with other metals. Certainly, when united to gold, its gravity must of course be specifically augmented: on the contrary, it must be lessened when united with any other metal, platina only excepted; and the same must be the case whether water or any other moisture is mixed with it; for in such a case the metal will be found heavier after evaportion. A simple boiling of the quicksilver over the fire in an open vessel will completely free it from this mixture; and no careful maker of experiments should neglect the preparation before he undertakes to employ mercury in any process, or for any purpose of the philosophic kind. The boiling must be continued for 20 or 30 minutes in order to expel the whole moisture.

Another cause by which the specific gravity of quicksilver becomes subject to alteration is the difference of temperature of the atmosphere at the time of making the experiment. Nor is it quicksilver alone, but every other substance whose specific gravity is affected by this cause in a greater or lesser degree; insomuch that Mr Magellan does not hesitate to pronounce the labours of all those who have undertaken to compose tables of specific gravities, without regard to this circumstance, to be, if not entirely useless, at least incapable of affording proper satisfaction in the nice inquiries that depend on this knowledge.

In Eisenchmid's table of specific gravities it is asserted, that a cubic inch of mercury in summer weighs seven ounces, one gros, 66 grains; but in winter it weighs 20 grains more: the whole weight then being seven ounces, two gros, 14 grains (allowing 72 grains to the gros). This, however, leaves the matter almost in as great uncertainty as before; the summer and winter temperature being widely different in different places, and very often even in the same place. Unless therefore the temperature of the air is attended to at every experiment in taking the specific gravity of any substance whatever, there can be no certainty of the result.

Quicksilver always feels cold when touched in the common temperature of the atmosphere. Our sensations, according to Fourcroy, deceive us in this case, for a thermometer dipped in quicksilver always shows the common temperature. "The great continuity of contact between the live skin and numerous metallic particles in an equal space, and which are proportional to its great specific gravity, necessarily produces a stronger sensation of its own temperature, this being always much less than that of a living body; and the multiplicity of these points of contact being all at once applied to this organ of sensation, must be more powerfully felt than whenever we touch any other matter that is lighter in itself, or of a less density." Quick-silver.

Notwithstanding this apparent coldness, however, quicksilver, when exposed to the same degree of heat, and in the same circumstances with various other substances, soon becomes hotter to the touch than any of them. "The fundamental principle of this (says Mr Magellan) consists in the small quantity of specific fire, or the less capacity which mercury is endowed with of receiving heat. This is such, that, compared with the capacity of water for the same purpose, it is in the ratio of 0.033 to 100, as appears by the table of the quantities of specific fire contained in various bodies.—This table, published in Magellan's Essay on Elementary Fire, was grounded upon various important experiments and observations made by Mr Kirwan, in consequence of the new Theory of Fire discovered by Dr Crawford. Hence it follows, that if equal quantities of heat be communicated to equal quantities of water and mercury, the latter will have a temperature 30 times greater than that of the water; that is to say, in the inverse ratio of their respective capacities, or as 1 to 30 (=0.033 : 1.000), in the same manner as it must happen, when equal measures of corn or of any fluid are thrown into vessels whose bottoms are as 30 to 1; for then their heights must necessarily be in their inverse ratio, viz. of 1 to 30, &c. See CHEMISTRY, n° 1225, &c.

Quicksilver does not appear to dissolve in water; but Fourcroy remarks, that physicians are in the practice of suspending a bag full of it in vermifuge ptisans during their ebullition, and that experience has evinced the good effects of it. Lemery asserts, that in this process there is no loss of weight; but this is denied by others. Fourcroy asserts, that this metal, rubbed between the fingers, emits a perceptible odour, though Magellan says he tried the experiment many times without success.

Fourcroy likewise asserts, that mercury when pure emits a phosphoric light by agitation, particularly in hot seasons. This phenomenon has certainly been observed in the mercury of the barometer; but its appearance on other occasions rests entirely on the authority of Mr Fourcroy. Even in the barometer it does not take place, unless the Torricellian vacuum be not perfectly made in the space at the top of the tube. Phials of glass nearly exhausted of air, and containing some quicksilver hermetically sealed up, will, on being shaken, produce as much light in the dark as is sufficient to show the hour on the dial-plate of a watch. But if a perfect vacuum be produced by nicely boiling the quicksilver within the glass, no appearance of this kind is to be perceived. The phenomenon is certainly of the electrical kind; and its not appearing in the perfect vacuum is owing to the difficulty there is in setting in motion any large quantity of electric matter by itself, which indeed can scarce be done without producing very violent effects. See *ELECTRICITY Index*.

Mercury unites with all the metals and semimetals, excepting iron and regulus of antimony. These compounds are called *amalgams*; and Mr Machy has observed,

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ſerved, that in forming them a certain degree of cold is produced. He made the experiment by covering the ball of a thermometer with tin-foil, and then dipping it into quickſilver; upon which that in the thermometer fell ſome degrees: which agrees perfectly well with the doctrine of latent heat firſt diſcovered by Dr Black, as it ſhows that in this, as well as other caſes, where a body paſſes from a ſolid into a fluid ſtate, a degree of cold is produced.—The following obſervations on the amalgams of mercury with different metals are extracted from the Memoirs of the Academicians of Dijon.

1. The amalgam of gold and mercury cryſtallizes into quadrangular pyramids. Six ounces of mercury are retained by one of gold in this cryſtallization; but that with ſilver retains a third part more of quickſilver.

2. The amalgam with ſilver is likewiſe ſuſceptible of cryſtallization, and aſſumes the form of a tree; every ounce of ſilver retaining eight of mercury. This amalgam, by means of the nitrous acid, well freed from the vitriolic by ſolution of ſilver in the ſame, forms that curious kind of vegetation mentioned in the article CHEMISTRY, n° 754, called *Arbor Dianæ*, or *Arbor Philoſophorum*.—The following is recommended by Mr Magellan as the ſhorteſt proceſs:

"Diſſolve 228 grains of ſilver, and half as much quickſilver, in pure nitrous acid. Add to the ſolution, when made, five ounces (of 576 grains each) of diſtilled water. Put this ſolution into a ſpherical veſſel of white glaſs, at the bottom of which muſt already be put 432 grains of an amalgam of ſilver of the conſiſtence of butter: let the veſſel be kept in a quiet place, free from any ſhaking or external agitation; and at the end of ſome few hours the figure of a buſh or tree of ſilver will be formed within the water of the glaſs veſſel. The metals contained in the ſolution and in the amalgam attract each other, and a number of ſmall tetrahedral cryſtals are formed, which lay hold at one another's end, and form the appearance of a vegetation.

3. Copper is amalgamated with mercury with great difficulty, and only by mixing blue vitriol with mercury and water in an iron retort over the fire. The acid then attacks the veſſel, and the copper is precipitated in a metallic ſtate, which, by ſtirring it with an hot iron ſpatula, unites to the mercury, but does not cryſtallize.

4. Two ounces of melted lead poured on a pound of mercury produce a half fluid amalgam, which being decanted gives ſome cryſtals like thoſe of ſilver. One ounce of theſe cryſtals retains an ounce and an half of mercury.

5. The amalgam of tin cryſtallizes into thin ſhining lamellæ, with polygonous cavities between one another. Two ounces of tin retain ſix of mercury in this cryſtallization.

6. Mercury amalgamates with biſmuth by means of heat, and produces cryſtals of an octohedral form, and lamellated triangles and hexagons. They are black on the upper ſurface, and ſhining underneath. In this cryſtallization the biſmuth retains double its weight of mercury.

7. *Zinc*, in fuſion, poured upon mercury, produces a crackling noiſe reſembling that produced by a hot body thrown into boiling water. It cryſtallizes very well into lamellated hexagonal figures, leaving cavities among themſelves. One ounce of zinc retains two and an half of mercury in this cryſtallization.

8. *Quickſilver* does not amalgamate with arſenic, except by heat, and then only in very ſmall quantity. This metal anſwers very important purpoſes both in medicine and the arts. Though it has no perceptible taſte, it produces very remarkable effects on the ſtomach and inteſtines of animals, as well as on the ſurface of the ſkin. Inſects and worms are extremely ſenſible of this effect, and the metal, almoſt in any ſtate, is exceedingly pernicious to them. Phyſicians, therefore, employ it as an excellent vermifuge (ſee MEDICINE, p. 341.), and it is likewiſe one of the moſt powerful remedies in the materia medica for many obſtinate diſorders beſides thoſe of the venereal kind, in which its efficacy has long been celebrated. "Even the moſt virulent product of mercury (ſays Mr Magellan), known by the name of ſublimate corroſive, which is the moſt violent poiſon, is often taken internally in very minute doſes, under the direction of ſkilful phyſicians, and produces the moſt happy effects in a great variety of caſes even of the moſt deſperate kind. This is a fact which I have experienced myſelf, in a dreadful ſcorbutic complaint which I ſuffered for above four years, with reſtleſs and violent pains in the eyes and head. None of the moſt able phyſicians in London and Paris I conſulted afforded me any effectual relief, till I had the good fortune to conſult Mr Sacre ſurgeon-oculiſt at Antwerp. His preſcription conſiſted of three grains of ſublimate diſſolved in a pint of common proof ſpirit. The doſe conſiſted in taking every morning two ſpoonfuls of it in a pint of new milk. In leſs than two months I began to feel relief; and in three months time was completely cured. The firſt methodical practice of this remedy was communicated to the celebrated Van Swieten, firſt phyſician to the Emperor's court, by the late Dr A. R. Sanches, then chief phyſician to the court of Peterſburg, as appears by the laſt volume of the Commentaries of the ſame Van Swieten, publiſhed in 1772. This volume was publiſhed after the author's death; but he had enjoyed during his life the glory of being the author of this wonderful remedy, which continues to bear his name among *the ignorant and inaccurate phyſicians* of our times."

But whatever uſes this ſalt may be put to when taken in ſmall quantities, it is certainly not leſs violent than arſenic itſelf, if taken in a large doſe; and the danger is the greater, on account of the difficult ſolution of the ſalt, which requires for this purpoſe 19 times its weight of water. Alkaline ſalts, however, prove a very effectual antidote, and will inſtantly relieve the ſymptoms; but, on account of the inſolubility of the poiſonous ſalt, the diſorders occaſioned by it ſoon return, and require a repetition of the ſame remedy. In caſes where alkaline ſalts are not immediately at hand, ſoap diſſolved in water will anſwer the ſame purpoſe; or if this alſo ſhould not be inſtantly procureable, chalk, lime, ſpirit of hartſhorn, or magneſia alba, might be uſed with good effect.

Quickſilver is employed in Chili and Peru to extract gold and ſilver, when native, from the earthy matters with which they are mixed. The principle on which this method is founded is the ſtrong mutual attraction betwixt mercury and the precious metals. By reaſon of this the ſmalleſt particles either of gold or ſilver form an amalgam with the mercury, part of which is ſtrained off, and the remainder either ſeparated by di-

ſtillation

Quick-silver, Quick-match.

ſtillation in iron retorts, or by a kind of diſtillation *per deſcenſum*; putting it in a kind of metallic ſieve over a veſſel of water, to receive the mercury, which is driven down by a fire lighted in a veſſel above the amalgam.

The amalgam with gold ſerves alſo to gild copper or ſilver, ſo that they appear as if made of ſolid gold.—For this purpoſe the pieces are to be well cleaned, and then dipped in a weak aquafortis; then in a nitrous ſolution of quickſilver, which covers them with a kind of ſilvering. After this the amalgam of gold is very equally ſpread over them; which being done, the piece is expoſed to a heat ſufficient to volatilize the quickſilver, and the gold is then left ſtrongly adhering to the metal. The only uſe to which the amalgam of mercury with lead has hitherto been applied, is the luting glaſs veſſels in which ſpecimens of natural hiſtory are to be preſerved in ſpirit of wine. For this it is more proper than any other ſubſtance, having an excellent effect in preventing evaporation. The amalgam of tin is commonly employed in making looking-glaſſes or mirrors. The thin ſheet of tin is laid down on a large flat table of ſtone; a proper quantity of mercury, in which ſome tin has already been diſſolved to prevent it from deſtroying the tin ſheet, is rubbed over with a bunch of cloth like a flat bung, and the glaſs carefully ſlided upon it from one end to the other, in ſuch a manner that the dirty cruſt of the quickſilver is driven off before its edge; and the glaſs is then loaded with weights all over: by inclining gradually the ſtone table, the ſuperfluous mercury is diſcharged; and in a few hours both cohere together. This amalgam is uſed for exciting the electricity of glaſs globes in the common electrical machines, but is ſaid to be inferior in ſtrength to that made with zinc.

Quickſilver heated by itſelf, with acceſs of air, is by degrees converted into a red powder, improperly called *Mercurius precipitatus per ſe*. It conſiſts of the calx of the metal united with the baſis of dephlogiſticated or pure air, which may be expelled from it again by a ſtrong heat; and this was the firſt method by which Dr Prieſtley obtained this kind of air.

Mercury is not altered by the contact of air: It is only obſerved, that it becomes tarniſhed by the particles of duſt which the air depoſits; and from that circumſtance mercury has been called the loadſtone of duſt.—Though all bodies have this property, it ſeems more remarkable in mercury than any other, on account of its great ſplendour; but it is not in the leaſt changed by this circumſtance, nothing more being neceſſary to reſtore it to its original brilliancy than filtration through a piece of ſhamoy leather.

The volatility of mercury prevents it from uniting with earths in the way of fuſion; though M. Fourcroy is of opinion that its red calx, or precipitate *per ſe*, might perhaps fix in glaſſes, and colour them, as is obſerved in the calx of arſenic.

QUICK-MATCH, among artillery men, a kind of combuſtible preparation formed of three cotton ſtrands drawn into length, and dipped in a boiling compoſition of white-wine vinegar, ſaltpetre, and mealed powder. After this immerſion it is taken out hot, and laid in a trough where ſome mealed powder, moiſtened with ſpirits of wine, is thoroughly incorporated into the twiſts of the cotton, by rolling it about therein. Thus prepared, they are taken out ſeparately, and drawn through mealed powder; then hung upon a line and dried, by which they are fit for immediate ſervice.

Quid ll Quietiſts.

QUID PRO QUO, in law, *q. d.* "what for what," denotes the giving one thing of value for another; or the mutual conſideration and performance of both parties to a contract.

QUID *pro quo*, or QUI *pro quo*, is alſo uſed in phyſic to expreſs a miſtake in the phyſician's bill, where *quid* is wrote for *quo*, i. e. one thing for another; or of the apothecary in reading *quid* for *quo*, and giving the patient the wrong medicine. Hence the term is in the general extended to all blunders or miſtakes committed in medicine, either in the preſcription, the preparation, or application of remedies.

QUIDDITY, QUIDDITAS, a barbarous term uſed in the ſchools for *eſſence*. The name is derived hence, that it is by the eſſence of a thing that it is *tale quid*, ſuch a *quid*, or thing, and not another. Hence what is eſſential to a thing is ſaid to be *quiddative*.

QUIETISTS, a religious ſect, famous towards the cloſe of the laſt century. They were ſo called from a kind of abſolute reſt and inaction, which they ſuppoſed the ſoul to be in when arrived at that ſtate of perfection which they called the *unitive life*; in which ſtate they imagined the ſoul wholly employed in contemplating its God, to whoſe influence it was entirely ſubmiſſive; ſo that he could turn and drive it where and how he would. In this ſtate, the ſoul no longer needs prayers, hymns, &c. being laid, as it were, in the boſom and between the arms of its God, in whom it is in a manner ſwallowed up.

Molinos, a Spaniſh prieſt, is the reputed author of Quietiſm; though the Illuminati in Spain had certainly taught ſomething like it before. The ſentiments of Molinos were contained in a book which he publiſhed at Rome in the year 1681, under the title of the *Spiritual Guide*; for which he was caſt into priſon in 1685, and where he publicly renounced the errors of which he was accuſed. This ſolemn recantation, however, was followed by a ſentence of perpetual impriſonment, and he died in priſon in the year 1696. Molinos had numerous diſciples in Italy, Spain, France, and the Netherlands. One of the principal patrons and propagators of Quietiſm in France was Marie Bouvieres de la Mothe Guyon, a woman of faſhion, remarkable for goodneſs of heart and regularity of manners; but of an unſettled temper, and ſubject to be drawn away by the ſeduction of a warm and unbridled fancy. She derived all ideas of religion from the feelings of her own heart, and deſcribed its nature to others as ſhe felt it herſelf. Accordingly, her religious ſentiments made a great noiſe in the year 1687; and they were declared unſound, after accurate inveſtigation, by ſeveral men of eminent piety and learning, and profeſſedly confuted, in the year 1697, by the celebrated Boſſuet. Hence aroſe a controverſy of greater moment between the prelate laſt mentioned and Fenelon archbiſhop of Cambray, who ſeemed diſpoſed to favour the ſyſtem of Guyon, and who in 1697 publiſhed a book containing ſeveral of her tenets. Fenelon's book, by means of Boſſuet, was condemned in the year 1699, by Innocent XII. and the ſentence of condemnation was read by Fenelon himſelf at Cambray, who exhorted the people to reſpect and obey the papal decree.

Not-

Quietiſts || Quills.

Notwithſtanding this ſeeming acquieſcence, the archbiſhop perſiſted to the end of his days in the ſentiments, which, in obedience to the order of the pope, he retracted and condemned in a public manner.

A ſect ſimilar to this had appeared at Mount Athos in Theſſaly, near the end of the 14th century, called *Heſychaſts*, meaning the ſame with Quietiſts. They were a branch of the myſtics, or thoſe more perfect monks, who, by long and intenſe contemplation, endeavoured to arrive at a tranquillity of mind free from every degree of tumult and perturbation. In conformity to an ancient opinion of their principal doctors (who thought there was a celeſtial light concealed in the deepeſt retirements of the mind), they uſed to ſit every day, during a certain ſpace of time, in a ſolitary corner, with their eyes eagerly and immoveably fixed upon the middle regions of the belly or navel; and boaſted, that while they remained in this poſture, they found, in effect, a divine light beaming forth from their ſoul, which diffuſed through their hearts inexpreſſible ſenſations of pleaſure and delight. To ſuch as inquired what kind of light this was, they replied, by way of illuſtration, that it was the glory of God, the ſame celeſtial radiance that ſurrounded Chriſt during his transfiguration on the Mount. Barlaam, a monk of Calabria, from whom the Barlaamites derived their denomination, ſtyled the monks who adhered to this inſtitution *Maſſalians* and *Euchites*; and he gave them alſo the new name of *Umbilicani*. Gregory Palamas, archbiſhop of Theſſalonica, defended their cauſe againſt Barlaam, who was condemned in a council held at Conſtantinople in the year 1341.—See *Fenelon's Max. des Saints*.

The Mahometans ſeem to be no ſtrangers to quietiſm. They expound a paſſage in the 17th chapter of the Koran, viz. "O thou ſoul which art at reſt, return unto thy Lord, &c." of a ſoul which, having, by purſuing the concatenation of natural cauſes, raiſed itſelf to the knowledge of that being which produced them, and exiſts of neceſſity, reſts fully contented, and acquieſces in the knowledge, &c. of him, and in the contemplation of his perfection.

QUILLET (Claude), an eminent Latin poet of the 17th century, was born at Chinon, in Touraine, and practiſed phyſic there with reputation: but having declared againſt the pretended poſſeſſion of the nuns of Loudun, in a manuſcript treatiſe, the original of which was depoſited in the library of the Sorbonne, he was obliged to retire into Italy, where he became ſecretary to the marſhal d'Eſtrees, the French ambaſſador at Rome. In 1655 Quillet having publiſhed in Holland a Latin poem, entitled *Callipædia*, under the name of *Galvidius Lætus*, he there inſerted ſome verſes againſt the cardinal Mazarine and his family; but that cardinal making him ſome gentle reproaches, he retrenched what related to the cardinal in another edition, and dedicated it to him, Mazarine having, before it was printed, given him an abbey. He died in 1661, aged 59, after having given Menage all his writings, and 500 crowns to pay the expence of printing them; but the abbé took the money and papers, and publiſhed none of them. His *Callipædia*, or the art of getting beautiful children, has been tranſlated into Engliſh verſe.

QUILLS, the large feathers taken out of the end of the wing of a gooſe, crow, &c. They are denominated from the order in which they are fixed in the wing; the ſecond and third quills being the beſt for writing, as they have the largeſt and roundeſt barrels. Crow-quills are chiefly uſed for drawing. In order to harden a quill that is ſoft, thruſt the barrel into hot aſhes, ſtirring it till it is ſoft, and then taking it out, preſs it almoſt flat upon your knee with the back of a penknife, and afterwards reduce it to a roundneſs with your fingers. If you have a number to harden, ſet water and alum over the fire, and while it is boiling put in a handful of quills, the barrels only, for a minute, and then lay them by.

Quin, Quinarius.

QUIN (James), a celebrated performer on the Engliſh ſtage, was born at London in 1693. He was intended for the bar; but preferring Shakeſpeare to the ſtatutes at large, he on the death of his father, when it was neceſſary for him to do ſomething for himſelf, appeared on the ſtage at Drury-lane. In 1720, he firſt diſplayed his comic powers in the character of Falſtaff, and ſoon after appeared to as great advantage in Sir John Brute; but it was upon Booth's quitting the ſtage that Quin appeared to full advantage, in the part of Cato. He continued a favourite performer until the year 1748, when, on ſome diſguſt between him and Mr Rich the manager, he retired to Bath, and only came up annually to act for the benefit of his friend Ryan; until the loſs of two front teeth ſpoiled his utterance for the ſtage. While Mr Quin continued upon the ſtage, he conſtantly kept company with the greateſt geniuſes of the age. He was well known to Pope and Swift; and the earl of Cheſterfield frequently invited him to his table: but there was none for whom he entertained a higher eſteem than for the ingenious Mr Thomſon, to whom he made himſelf known by an act of generoſity that does the greateſt honour to his character; and for an account of which ſee our life of THOMSON. Mr Quin's judgment in the Engliſh language recommended him to his royal highneſs Frederick prince of Wales, who appointed him to inſtruct his children in ſpeaking and reading with a graceful propriety; and Quin being informed of the elegant manner in which his preſent majeſty delivered his firſt gracious ſpeech from the throne, he cried out in a kind of ecſtaſy, "Ay—I taught the boy to ſpeak!" Nor did his majeſty forget his old tutor; for, ſoon after his acceſſion to the throne, he gave orders, without any application being made to him, that a genteel penſion ſhould be paid to Mr Quin during his life. Mr Quin, indeed, was not in abſolute need of this royal benefaction; for as he was never married, and had none but diſtant relations, he ſunk 2000 l. which was half his fortune, in an annuity, for which he obtained 200 l. a-year; and with about 2000 l. more in the funds, lived in a decent manner during the latter part of his life at Bath, from whence he carried on a regular correſpondence with Mr Garrick, and generally paid a viſit to his friends in the metropolis once a year, when he conſtantly paſſed a week or two at Mr Garrick's villa at Hampton. He died of a fever in 1766.

QUINARIUS, was a ſmall Roman coin equal to half the denarius, and conſequently worth about three pence three farthings of our money. See MONEY.

Quinaut || Quinqueremis.

It was called *quinarius*, becauſe it contained the value of five aſſes, in the ſame manner as the denarius was named from its containing ten.

QUINAUT (Philip), a celebrated French poet, born of a good family at Paris in 1635. He cultivated poetry from his infancy, and 16 dramatic pieces of his were acted between the year 1653 and 1666. In the mean time, Quinaut was not ſo much devoted to poetry but that he applied himſelf to the ſtudy of the law; and made his fortune by marrying the widow of a rich merchant to whom he had been uſeful in his profeſſion. Quinaut afterwards turned his attention to the compoſing of operas, which were ſet to muſic by the famous Lully; and Lully was charmed with a poet whoſe verſes were not too nervous to yield to the capricious airs of muſic. He died in 1688, after having enjoyed a handſome penſion from Louis XIV. for many years: and we are told he was extremely penitent in his laſt illneſs for all thoſe of his compoſitions which tended to inſpire love and pleaſure.

QUINCE, in botany. See CYDONIA.

QUINCUNX, in Roman antiquity, denotes any thing that conſiſts of five-twelfths of another; but particularly of the *as*.

QUINCUNX *Order*, in gardening, is a plantation of trees, diſpoſed originally in a ſquare conſiſting of five trees, one at each corner, and a fifth in the middle; which diſpoſition, repeated again and again, forms a regular grove, wood, or wilderneſs.

QUINDECAGON, in geometry, a plain figure with 15 ſides and 15 angles.

QUINDECEMVIRI, in Roman antiquity, a college of 15 magiſtrates, whoſe buſineſs it was to preſide over the ſacrifices. They were alſo the interpreters of the Sybil's books; which, however, they never conſulted but by an expreſs order of the ſenate.

QUINQUAGENARIUS, in Roman antiquity, an officer who had the command of 50 men.

QUINQUAGESIMA SUNDAY, Shrove Sunday, ſo called as being about the 50th day before Eaſter.

QUINQUATRIA, or QUINQUATRUS, was a feſtival kept at Rome in honour of Minerva, which began on the 18th of March, or as others will have it on the 19th, and laſted five days. On the firſt day they offered ſacrifices and oblations without the effuſion of blood; the ſecond, third, and fourth, were ſpent in ſhows of gladiators; and on the fifth day they went in proceſſion through the city. Scholars had a vacation during the ſolemnity, and preſented their maſters at this time with a gift or fee, called *Minerval*. Boys and girls uſed now to pray to the goddeſs Minerva for wiſdom and learning, of which ſhe had the patronage. Plays were acted, and diſputations held, at this feaſt, on ſubjects of polite literature. The quinquatria were ſo called, becauſe they laſted for five days. There ſeems to be a ſtrong reſemblance betwixt this feſtival and the panathenæa of the Greeks.

QUINQUENNALIS, in Roman antiquity, a magiſtrate in the colonies and municipal cities of that empire, who had much the ſame office as the ædile at Rome.

QUINQUEREMIS, in the naval architecture of the ancients, a name given to a galley which had five rows of oars. They divided their veſſels in general into *monocrota* and *polycrota**. The former had only one tire of rowers: the latter had ſeveral tires of them, from two or three up to 20, 30, or even 40; for ſuch a veſſel we have an account of in the time of Philopater, which required no leſs than 4000 men to row it.

* See Polycrota.

Quinqueviri || Quintilianus.

Meibom has taken off from the imaginary improbability of there ever having been ſuch a veſſel, by reducing the enormous height ſuppoſed neceſſary for ſuch a number of rows of oars and men to work them, by finding a better way of placing the men than others had thought of. The quinqueremes of the ancients had 420 men in each; 300 of which were rowers, and the reſt ſoldiers. The Roman fleet at Meſſina conſiſted of 330 of theſe ſhips; and the Carthaginian, at Lilybœum, of 350 of the ſame ſize. Each veſſel was 150 feet long. Thus 130,000 men were contained in the one, and 150,000 in the other, with the apparatus and proviſions neceſſary for ſuch expeditions as they were intended for. This gives ſo grand an idea of the ancient naval armaments, that ſome have queſtioned the truth of the hiſtory: but we find it related by Polybius, an hiſtorian too authentic to be queſtioned, and who expreſſes his wonder at it while he relates it.

QUINQUEVIRI, in Roman antiquity, an order of five prieſts, peculiarly appointed for the ſacrifices to the dead, or celebrating the rites of Erebus.

QUINQUINA. See CINCHONA.

QUINSY, or QUINZY. See MEDICINE, n° 177—183.

QUINTEN, a town of France, in Bretagne, with the title of a duchy, and a handſome caſtle. It is ſeated in a valley near the river Guy, and near a large foreſt of the ſame name, eight miles ſouth of St Brieux, and 200 weſt of Paris. W. Long. 2. 40. N. Lat. 48. 26.

QUINTESSENCE, in chemiſtry, a preparation conſiſting of the eſſential oil of ſome vegetable ſubſtance, mixed and incorporated with ſpirit of wine.

QUINTESSENCE, in alchemy, is a myſterious term, ſignifying the fifth or laſt and higheſt eſſence of power in a natural body.

QUINTILE, in aſtronomy, an aſpect of the planets when they are 72 degrees diſtant from one another, or a fifth part of the zodiac.

QUINTILIANUS (Marcus Fabius), a celebrated Latin orator, and the moſt judicious critic of his time, was a native of Calagurris, or Calahorra, in Spain; and was the diſciple of Domitius Afer, who died in the year 59. He taught rhetoric at Rome for 20 years with great applauſe: and not only laid down rules for ſpeaking, but exhibited his eloquence at the bar. Some authors imagine, but with little foundation, that he arrived to the conſulſhip; but it is more certain that he was preceptor to the grandſons of the emperor Domitian's ſiſter. There is ſtill extant his excellent work, intitled, *Inſtitutiones Oratoriæ*, which is a treatiſe of rhetoric in 12 books; where his precepts, judgment, and taſte, are juſtly admired. Theſe inſtitutions were found entire by Poggius, in an old tower of the abbey of St Gal, and not in a grocer's ſhop in Germany as ſome authors have imagined. There is alſo attributed to Quintilian a dialogue *De cauſis corruptæ eloquentiæ*; but it is more commonly aſcribed to Tacitus. The beſt editions of Quintilian's works are thoſe of Mr Obreight, publiſhed at Straſburg in 2 vols 4to, in 1698, and of M. Capperonier, in folio. There is an Engliſh tranſlation by Mr Guthrie.

Quintilians || Quintus.

Quintilian had a ſon of the ſame name, on whom he beſtows great praiſes. This ſon ought not to be confounded with Quintilian the father, or rather the grandfather, of him who is the ſubject of this article, and who wrote 145 declamations. Ugolin of Parma publiſhed the firſt 136 in the 15th century; the nine others were publiſhed in 1563 by Peter Ayrault, and afterwards by Peter Pithou in 1580. There have alſo been 19 other declamations printed under the name of Quintilian the Orator; but, in the opinion of Voſſius, they were written neither by that orator nor his grandfather.

QUINTILIANS, a ſect of ancient heretics, thus called from their propheteſs Quintilia. In this ſect the women were admitted to perform the ſacerdotal and epiſcopal functions. They attributed extraordinary gifts to Eve for having firſt eaten of the tree of knowledge; told great things of Mary the ſiſter of Moſes, as having been a propheteſs, &c. They added, that Philip the deacon had four daughters, who were all propheteſſes, and were of their ſect. In theſe aſſemblies it was uſual to ſee the virgins entering in white robes, perſonating propheteſſes.

QUINTIN MATSYS, alſo called the *Farrier of Antwerp*, famous for being transformed, by the force of love, from a blackſmith to a painter. He had followed the trade of a blackſmith and farrier near twenty years; when falling in love with a painter's daughter who was very handſome, and diſliked nothing but his trade, he quitted it, and betook himſelf to painting, in which he made a very uncommon progreſs. He was a diligent and careful imitator of ordinary life, and ſucceeded better in repreſenting the defects than the beauties of nature. Some hiſtorical performances of this maſter deſerve commendation, particularly a Deſcent from the Croſs, in the Cathedral at Antwerp: but his beſt known picture is that of the two Miſers in the gallery at Windſor. He died in 1529.

QUINTINIE (John de la), a celebrated French gardener, born at Poictiers in 1626. He was brought up to the law; and acquitted himſelf ſo well at the bar as to acquire the eſteem of the chief magiſtrate. M. Tamboneau, preſident of the chamber of accounts, engaged him to undertake the preceptorſhip of his only ſon, which Quintinie executed entirely to his ſatisfaction; applying his leiſure hours to the ſtudy of writers on agriculture, ancient and modern, to which he had a ſtrong inclination. He gained new lights by attending his pupil to Italy; for all the gardens about Rome being open to him, he failed not to add practice to his theory. On his return to Paris, M. Tamboneau gave up the management of his garden entirely to him; and Quintinie applied ſo cloſely to it, that he became famous all over France. Louis XIV. erected a new office purpoſely for him, that of director of the royal fruit and kitchen gardens; and theſe gardens, while he lived, were the admiration of the curious. He lived to a good old age, though we learn not the time of his death; his Directions for the Management of Fruit and Kitchen Gardens are eſteemed all over Europe.

QUINTUS CALABER, a Greek poet, who wrote a large Supplement to Homer's Iliad, in 14 books, in which a relation is given of the Trojan war from the death of Hector to the deſtruction of Troy. It is conjectured, from his ſtyle and manner, that he lived in the fifth century. Nothing certain can be collected either concerning his perſon or country. His poem was firſt made known by Cardinal Beſſarion, who diſcovered it in St Nicolas's church, near Otranto in Calabria; from whence the author was named *Quintus Calaber*. It was firſt publiſhed at Venice by Aldus, but it is not ſaid in what year.

Quintus || Quito.

QUINTUS CURTIUS. See CURTIUS.

QUINZY, QUINSEY, or *Angina Pectoris*. See MEDICINE, n° 403.

QUIRE OF PAPER, the quantity of 24 or 25 ſheets.

QUIRINALIA, in antiquity, a feaſt celebrated among the Romans in honour of Romulus.

QUIRITES, in Roman antiquity. In conſequence of the agreement entered into by Romulus and Tatius king of the Sabines, Rome was to retain its name, taken from Romulus; and the people were to be called *Quirites*, from Cures, the principal town of the Sabines, a name uſed in all public addreſſes to the Roman people. ——Dion. Hal. ſays, that each particular citizen was to be called *Romanus*, and the collective body of them *Quirites*; yet it appears by this ancient form of words uſed at funerals, *Ollus Quiris letho datus eſt*, that each private citizen was alſo called *Quiris*.

The origin of the word *Quirites*, which was at firſt peculiar to the Sabines, and became, in Romulus's time, the general name of the inhabitants of Rome, has been much ſought for; and the moſt probable account antiquity gives us of it, is this: The word *Quiris*, according to Plutarch and ſome others, ſignified, in the Sabine language, both "a dart," and "a warlike deity armed with a dart." It is uncertain whether the god gave name to the dart, or the dart to the god. But be that as it will, this *Quiris*, or *Quirinus*, was either Mars or ſome other god of war; and the worſhip of *Quiris* continued in Rome all Romulus's reign: but after his death he was honoured with the name *Quirinus*, and took the place of the god *Quiris*.

QUIRK, in a general ſenſe, denotes a ſubtilty or artful diſtinction.

QUIRK, in building, a piece of ground taken out of any regular ground-plot, or floor: thus, if the ground-plot were oblong or ſquare, a piece taken out of a corner to make a court or yard, &c. is called a *quirk*.

QUISQUALIS, in botany: A genus of the monogynia order, belonging to the decandria claſs of plants; and in the natural method ranking under the 31ſt order, *Vepreculæ*. The calyx is quinquefid and filiform; the petals five; the fruit is a quinqueangular plum. There is only one ſpecies, viz. INDICA.

QUITO, a town of South America, in Peru (ſee PERU, p. 213.), ſeated between two chains of high mountains called *Cordillera de los Andes*, on much higher ground than the reſt of habitable Peru. It is 300 yards higher than the level of the ſea according to the exacteſt obſervations. The town is 1600 yards long and 1200 broad, and is the ſeat of a biſhop. It contains about 35,000 inhabitants, one third of whom are originally Spaniards. Among the inhabitants are ſome perſons of high rank and diſtinction, deſcended either from the original conquerors, or perſons who at different times came from Spain inveſted with ſome lucrative poſt. The number of theſe, however, is but ſmall. The commonalty, beſides Spaniards, conſiſt of Meſtizos, Indians, and Negroes; but the laſt are not

Quito || Quoin.

proportionally numerous. Merchandizes and commodities of all ſorts are extremely dear, partly on account of the difficulty of bringing them.

There are ſeveral religious communities at Quito, and two colleges or univerſities governed by Jeſuits and Dominicans.

The principal courts held at Quito are that of the royal audience, which conſiſts of the preſident, who is governor of the province with regard to law affairs; four auditors, who are at the ſame time civil and criminal judges; a royal fiſcal, who, beſides the cauſes brought before the audience, takes cognizance of every thing relating to the revenue; and an officer ſtyled the *protector of the Indians*, who ſolicits for them, and when they are injured pleads in their defence. The next is the treaſury, the chief officers of which are an accountant, a treaſurer, and a royal fiſcal. The tribunal of the Croiſade, which has a commiſſary, who is generally ſome dignitary of the church, and a treaſurer. There is alſo a treaſury for the effects of perſons deceaſed: an inſtitution eſtabliſhed all over the Indies, for receiving the goods of thoſe whoſe lawful heirs are in Spain, in order to ſecure them from thoſe accidents to which they might be liable in private hands. There is likewiſe a commiſſary of the inquiſition, with an alguazil-major and familiars, appointed by the inquiſition at Lima. The corporation conſiſts of a corregidor, two ordinary alcaldes, choſen annually, and regidores. The latter ſuperintend the election of the alcaldes, which is attended with no ſmall diſturbance, the people being divided into two parties, the Creoles and Europeans.

QUITTER-BONE, in farriery. See there, § xl. 4.

QUIT-RENT (*quietus reddítus*, i. e. "quiet rent,") is a certain ſmall rent payable by the tenants of manors, in token of ſubjection, and by which the tenant goes quiet and free. In ancient records it is called *white rent*, becauſe paid in ſilver money, to diſtinguiſh it from rent-corn, &c.

QUOIN, or COIN, on board a ſhip, a wedge faſtened on the deck cloſe to the breach of the carriage of a gun, to keep it firm up to the ſhip's ſide. Cantic quoins are ſhort three-legged quoins put between caſks to keep them ſteady.

Quoins || Quotients

QUOINS, in architecture, denote the corners of brick or ſtone walls. The word is particularly uſed for the ſtones in the corners of brick buildings. When theſe ſtand out beyond the brick-work, their edges being chamfred off, they are called *ruſtic quoins*.

QUOTIDIAN, any thing which happens every day. Hence, when the paroxyſms of an ague recur every day, it is called a *quotidian ague*. See MEDICINE, n° 161—164.

QUOTIDIANA DECEPTIVA. See MEDICINE, n° 150.

QUOAD HOC, is a term uſed in the pleadings and arguments of lawyers; being as much as to ſay, As to this thing the law is ſo and ſo.

QUORUM, a word frequently mentioned in our ſtatutes, and in commiſſions both of juſtices of the peace and others. It is thus called from the words of the commiſſion, *quorum* A. B. *unum eſſe volumus*. For an example, where a commiſſion is directed to ſeven perſons, or to any three of them, whereof A. B. and C. D. are to be two; in this caſe, they are ſaid to be of the quorum, becauſe the reſt cannot proceed without them: ſo a juſtice of the peace and quorum is one without whom the reſt of the juſtices in ſome caſes cannot proceed.

QUOTIENT, in arithmetic, the number reſulting from the diviſion of a greater number by a ſmaller; and which ſhows how often the ſmaller is contained in the greater, or how often the diviſor is contained in the dividend. The word is formed from the Latin *quoties*; *q. d.* How often is ſuch a number contained in ſuch another?

In diviſion, as the diviſor is to the dividend, ſo is unity to the quotient.—Thus the quotient of 12 divided by 3 is 4; which is thus diſpoſed, 3) 12 (4 quotient. See ARITHMETIC.

R.

R, or *r*, a liquid conſonant, being the 17th letter of our alphabet. Its ſound is formed by a guttural extruſion of the breath vibrated through the mouth, with a ſort of quivering motion of the tongue drawn from the teeth, and canulated with the tip a little elevated towards the palate. In Greek words it is frequently aſpirated with an *h* after it, as in *rhapſody*, *rhetoric*, &c. otherwiſe it is always followed by a vowel at the beginning of words and ſyllables.

In the notes of the ancients, R. or RO. ſignifies *Roma*; R. C. *Romana civitas*; R. G. C. *rei gerendæ cauſa*; R. F. E. D. *recte factum et dictum*; R. G. F. *regis filius*; R. P. *res publica*, or *Romani principes*; and R. R. R. F. F. F. *res Romana ruet ferro, fame, flamma.*

Uſed as a numeral, R anciently ſtood for 80; and with a daſh over it, thus $\overline{R}$, for 80,000; but the Greek *r*, ρ', with a ſmall mark over it, ſignified 100; with the ſame mark under it, it denoted 1000 × 100; thus $\rho_{,}$ ſignified 100,000. In the Hebrew numeration ר denoted 200: and with two horizontal points over it 1000 × 200; thus $\ddot{ר} = 200{,}000$.

In the preſcriptions of phyſicians, R or ℞ ſtands for *recipe*, *i. e.* "take."

RAAB, a town of Lower Hungary, capital of Javerin, with a caſtle and a biſhop's ſee. It is a ſtrong frontier bulwark againſt the Turks, and has two bridges, one over a double ditch, and another that leads towards Alba Regalis. The ſurrounding country is plain, and there

Rabac || Rabbetting.

there is nothing that ſeems to command it but a ſmall hill at ſome diſtance, which is undermined and may be blown up. It was taken by Amurath III. with the loſs of 20,000 men; but was ſurpriſed ſoon after by Count Palfi, who killed all the Turks that were found therein. It is ſeated at the confluence of the rivers Rab and Rabnitz, not far from the Danube, 32 miles weſt of Gran, and 55 ſouth-eaſt of Vienna. E. Long. 17. 25. N. Lat. 47. 48.

RABAC, a ſmall port on the Arabian coaſt of the Red Sea, in N. Lat. 22° 35′ 40″ by Mr Bruce's account. The entry to the harbour is from the E. N. E. and is about a quarter of a mile broad. The port extends about two miles in length to the eaſtward. The mountains are about three leagues to the north, and the town about four miles north by eaſt from the entrance to the harbour. The water is good, and all ſhips may be ſupplied here from the wells which are in the neighbourhood of the town. The country is bare and uncultivated; but from the appearance of it, and the freſhneſs of the water, Mr Bruce ſuppoſes that it ſometimes rains among the mountains here, which is the more probable as it is conſiderably within the tropic.

RABAT, a large and handſome ſea-port town of Africa, in the kingdom of Fez and province of Tremeſen. It has fine moſques and handſome palaces, and is ſeated at the mouth of the river Burrigrig, almoſt in the mid-way between Fez and Tangier. W. Long. 5. 28. N. Lat. 34. 40.

Rabat, together with Sallee, which is oppoſite to it, was formerly famous for fitting out piratical veſſels; but the late emperor Sidi Mahomet ſubdued them both, and annexed them to the empire; ſince which time the harbour of Rabat has been ſo filled with the ſand waſhed in by the ſea as to render it unfit to carry on ſuch piracies in future.

The town of Rabat, whoſe walls incloſe a large ſpace of ground, is defended on the ſea-ſide by three forts tolerably well finiſhed, which were erected ſome little time ago by an Engliſh renegado, and furniſhed with guns from Gibraltar. The houſes in general are good, and many of the inhabitants are wealthy. The Jews, who are very numerous in this place, are generally in better circumſtances than thoſe of Larache or Tangier, and their women are extremely beautiful.

The caſtle, which is very extenſive, contains a ſtrong building, formerly uſed by the late emperor as his principal treaſury, and a noble terrace, which commands an extenſive proſpect of the town of Sallee, the ocean, and all the neighbouring country. There are alſo the ruins of another caſtle, which is ſaid to have been built by Jacob Almonzor, one of their former emperors, and of which at preſent very little remains but its walls, containing within them ſome very ſtrong magazines for powder and naval ſtores. On the outſide of theſe walls is a very high and ſquare tower, handſomely built of cut ſtone, and called the tower of *Haſſen*. From the workmanſhip of this tower, contraſted with the other buildings, a very accurate idea may be formed how greatly the Moors have degenerated from their former ſplendour and taſte for architecture.

RABBETTING, in carpentry, the planning or cutting of channels or grooves in boards, &c.

In ſhip-carpentry, it ſignifies the letting in of the planks of the ſhip into the keel; which, in the rake and run of a ſhip, is hollowed away, that the planks may join the cloſer.

Rabbi || Rabelais.

RABBI, or RABBINS, a title which the Phariſees and doctors of the law among the Jews aſſumed, and literally ſignifies *maſters* or *excellents*.

There were ſeveral gradations before they arrived at the dignity of a rabbin; which was not conferred till they had acquired the profoundeſt knowledge of the law and the traditions. It does not, however, appear that there was any fixed age or previous examination neceſſary; but when a man had diſtinguiſhed himſelf by his ſkill in the written and oral law, and paſſed through the ſubordinate degrees, he was ſaluted a rabbi*n* by the public voice.

Among the modern Jews, for near 700 years paſt, the learned men retain no other title than that of *rabbi*, or *rabbins*; they have great reſpect paid them, have the firſt places or ſeats in their ſynagogues, determine all matters of controverſy, and frequently pronounce upon civil affairs; they have even power to excommunicate the diſobedient.

RABBINISTS, among the modern Jews, an appellation given to the doctrine of the rabbins concerning traditions, in oppoſition to the Caraites; who reject all traditions. See CARAITE.

RABELAIS (Francis), a French writer famous for his facetiouſneſs, was born at Chinon in Touraine about the year 1483. He was firſt a Franciſcan friar; but quitting his religious habit ſtudied phyſic at Montpelier, where he took his doctor's degree. It is ſaid, that the chancellor du Pratt having aboliſhed the privileges of the faculty of phyſic at Montpelier by a decree of the parliament, Rabelais had the addreſs to make him revoke what he had done; and that thoſe who were made doctors of that univerſity wore Rabelais's robe, which is there held in great veneration. Some time after, he came to Rome, in quality of phyſician in ordinary to Cardinal John du Bellay archbiſhop of Paris. Rabelais is ſaid to have uſed the freedom to jeer Pope Paul III. to his face. He had quitted his religious connections for the ſake of leading a life more agreeable to his taſte; but renewed them on a ſecond journey to Rome, when he obtained, in 1536, a brief to qualify him for holding eccleſiaſtical benefices; and, by the intereſt of his friend Cardinal John du Bellay, he was received as a ſecular canon in the abbey of St Maur near Paris. His profound knowledge in phyſic rendered him doubly uſeful; he being as ready, and at leaſt as well qualified, to preſcribe for the body as for the ſoul: but as he was a man of wit and humour, many ridiculous things are laid to his charge, of which he was quite innocent. He publiſhed ſeveral things; but his chief performance is a ſtrange incoherent romance, called the *Hiſtory of Gargantua and Pantagruel*, being a ſatire upon prieſts, popes, fools, and knaves of all kinds. This work contains a wild, irregular profuſion of wit, learning, obſcenity, low conceits, and arrant nonſenſe; hence the ſhrewdneſs of his ſatire, in ſome places where he is to be underſtood, gains him credit for thoſe where no meaning is diſcoverable. Some alluſions may undoubtedly have been ſo temporary and local as to be now quite loſt: but it is too much to conclude thus in favour of every unintelligible rhapſody; for we are not without Engliſh writers of great talents, whoſe ſportive geniuſes have betrayed them into puerilities, no leſs incoherent at

Rabbit. the times of writing than thoſe of Rabelais appear above two centuries after. He died about 1553.

RABBIT, in zoology. See LEPUS.

The buck rabbits, like our boar cats, will kill the young ones if they can get at them; and the does in the warrens prevent this, by covering their ſtocks, or neſts, with gravel or earth, which they cloſe ſo artificially up with the hinder part of their bodies, that it is hard to find them out. They never ſuckle their young ones at any other time than early in the morning and late at night; and always, for eight or ten days, cloſe up the hole at the mouth of the neſt, in this careful manner when they go out. After this they begin to leave a ſmall opening, which they increaſe by degrees; till at length, when they are about three weeks old, the mouth of the hole is left wholly open that they may go out; for they are at that time grown big enough to take care of themſelves, and to feed on graſs.

People who keep rabbits tame for profit, breed them in hutches; but theſe muſt be kept very neat and clean, elſe they will be always ſubject to diſeaſes. Care muſt be taken alſo to keep the bucks and does apart till the latter have juſt kindled; then they are to be turned to the bucks again, and to remain with them till they ſhun and run from them.

The general direction for the chooſing of tame rabbits is, to pick the largeſt and faireſt; but the breeder ſhould remember that the ſkins of the ſilver-haired ones ſell better than any other. The food of the tame rabbits may be colewort and cabbage-leaves, carrots, parſneps, apple-rinds, green corn, and vetches, in the time of the year; alſo vine-leaves, graſs, fruits, oats, and oatmeal, milk-thiſtles, ſow-thiſtles, and the like: but with theſe moiſt foods they muſt always have a proportionable quantity of the dry foods, as hay, bread, oats, bran, and the like, otherwiſe they will grow pot-bellied, and die. Bran and grains mixed together have been alſo found to be very good food. In winter they will eat hay, oats, and chaff, and theſe may be given them three times a-day; but when they eat green things, it muſt be obſerved that they are not to drink at all, for it would throw them into a dropſy. At all other times a very little drink ſerves their turn, but that muſt always be freſh. When any green herbs or graſs are cut for their food, care muſt be taken that there be no hemlock among it; for though they will eat this greedily among other things when offered to them, yet it is ſudden poiſon to them.

Rabbits are ſubject to two principal infirmities. Firſt, the rot, which is cauſed by giving them too large a quantity of greens, or from giving them freſh gathered with the dew or rain hanging in drops upon them. It is over-moiſture that always cauſes this diſeaſe. The greens therefore are always to be given dry; and a ſufficient quantity of hay, or other dry food, intermixed with them, to take up the abundant moiſture of their juices. On this account the very beſt food that can be given them, is the ſhorteſt and ſweeteſt hay that can be got, of which one load will ſerve 200 couples a year; and out of this ſtock of 200, 200 may be eat in the family, 200 ſold to the markets, and a ſufficient number kept in caſe of accidents.

The other general diſeaſe of theſe creatures is a ſort of madneſs: this may be known by their wallowing and tumbling about with their heels upwards, and hopping in an odd manner into their boxes. This diſtemper is ſuppoſed to be owing to the rankneſs of their feeding; and the general cure is the keeping them low, and giving them the prickly herb called *tare-thiſtle* to eat. Rabbit.

The general computation of males and females is, that one buck-rabbit will ſerve for nine does: ſome allow 10 to one buck; but thoſe who go beyond this always ſuffer for it in their breed.

The wild rabbits are either to be taken by ſmall curdogs, or by ſpaniels bred up to the ſport; and the places of hunting thoſe who ſtraggle from their burrows, is under cloſe hedges or buſhes, or among corn-fields and freſh paſtures. The owners uſe to courſe them with ſmall greyhounds; and though they are ſeldom killed this way, yet they are driven back to their burrows, and are prevented from being a prey to others. The common method is by nets called *purſe-nets*, and ferrets. The ferret is ſent into the hole to fetch them out; and the purſe-net being ſpread over the hole, takes them as they come out. The ferrets mouths muſt be muffled, and then the rabbit gets no harm. For the more certain taking of them, it may not be improper to pitch up a hay-net or two, at a ſmall diſtance from the burrows that are intended to be hunted: thus very few of the number that are attempted will eſcape.

Some who have not ferrets ſmoke the rabbits out of their holes with burning brimſtone and orpiment. This certainly brings them out into the nets: but then it is a very troubleſome and offenſive method; and is very detrimental to the place, as no rabbit will for a long time afterwards come near the burrows which have been fumed with thoſe ſtinking ingredients.

The teſticle of a rabbit is a very good object for examining the ſtructure of this part of generation in animals. The whole ſubſtance of the teſticle in this animal is made up of veſſels, which lie in round folds in the manner of the ſmaller inteſtines: but then both ends of each roll meet at their inſertion, which ſeems to be made into the *ductus nervoſus*; and every one of theſe little rolls is curiouſly embroidered with other veſſels, which, from their red colour, appear to be arteries and veins. The ſeveral little rolls lie in ranges, diſpoſed with an uniformity which is very agreeable to the eye. Every one of theſe rolls is not a ſingle and entire tube, but each conſiſts of ſeveral tubes, beſide the veins and arteries which embroider it. This is beſt diſtinguiſhed by the cutting one of the rolls tranſverſely, and then examining the cut end with a glaſs, which will appear to be made up of the cut and open ends of four, five, or more parallel tubes, which together form the roll, or ſingle tube, as it appears to the eye, being all wrapped up in one common and very thin membrane. Theſe are ſo tender that they cannot be explicated and viewed diſtinct, as De Graaf tells us thoſe of the teſticles of a rat and of ſome other animals may. Theſe, however, as well as the others, are only made up of a congeries of veſſels, and the liquors, which are their contents, without any intermediate ſubſtance, or any thing of that parenchyma which many authors have talked of. The teſticles of a bull have the greateſt appearance of a fleſhy texture of thoſe of any known animal; yet even theſe afford no particle of parenchyma, or fleſh, when examined by glaſſes in any ſort of preparation, whether boiled, raw, ſoaked in ſpirits, or in whatever other ſtate.

The

Rabirius || Racine.

The teſticles of various animals are very variouſly compoſed, but all in this general manner of veſſels variouſly rolled and folded together: and even the human teſticles are of the ſame ſort; being compoſed ſolely of rolls of veſſels, without any intermediate ſubſtance, be it called by whatever name, but only conſiſting of veſſels and their liquors.

RABIRIUS (C.) a Roman knight, who lent an immenſe ſum of money to Ptolemy Auletes king of Egypt. The monarch afterwards not only refuſed to repay him, but even confined him, and endangered his life. Rabirius eſcaped from Egypt with difficulty; but at his return to Rome he was accuſed by the ſenate of having lent money to an African prince for unlawful purpoſes. He was ably defended by Cicero, and acquitted with difficulty.—There was a Latin poet of the ſame name in the age of Auguſtus. He wrote a poem on the victory which the emperor had gained over Antony at Actium. Seneca has compared him to Virgil for elegance and majeſty; but Quintilian is not ſo favourable to his poetry.—And there was an architect in the reign of Domitian, called *Rabirius*. He built a celebrated palace for the emperor, of which the ruins are ſtill ſeen at Rome.

RACCOON. See URSUS.

RACE, in general, ſignifies running with others in order to obtain a prize, either on foot, or by riding on horſeback, in chariots, &c.

The race was one of the exerciſes among the ancient Grecian games, which was performed in a courſe containing 125 paces; and thoſe who contended in theſe foot-races were frequently clothed in armour. Chariot and horſe races alſo made a part of theſe ancient games.

Races were known in England in very early times. Fitz-Stephen, who wrote in the days of Henry II. mentions the great delight that the citizens of London took in the diverſion. But by his words, it appears not to have been deſigned for the purpoſes of gaming, but merely to have ſprung from a generous emulation of ſhowing a ſuperior ſkill in horſemanſhip.

Races appear to have been in vogue in the reign of Queen Elizabeth, and to have been carried to ſuch exceſs as to injure the fortunes of the nobility. The famous George earl of Cumberland is recorded to have waſted more of his eſtate than any of his anceſtors; and chiefly by his extreme love to horſe-races, tiltings, and other expenſive diverſions. It is probable that the parſimonious queen did not approve of it; for races are not among the diverſions exhibited at Kennelworth by her favourite Leiceſter. In the following reign, were places allotted for the ſport: Croydon in the ſouth, and Garterly in Yorkſhire, were celebrated courſes. Camden alſo ſays, that in 1607 there were races near York, and the prize was a little golden bell. See RACING.

RACE, in genealogy, a lineage or extraction continued from father to ſon. See DESCENT.

RACINE (John), of the French academy, treaſurer of France in the generality of Moulins, and ſecretary to his majeſty, was born at Ferre-Milon in 1639. He had a fine genius for the *Belles Lettres*, and became one of the firſt poets of the age. He produced his *Thebaide* when but very young; and afterwards other pieces, which met with great ſucceſs, though they appeared when Corneille was in his higheſt reputation. In his career, however, he did not fail to meet with all that oppoſition which envy and cabal are ever ready to ſet up againſt a ſuperior genius. It was partly owing to a chagrin from this circumſtance that he took a reſolution to quit the theatre for ever; although his genius was ſtill in full vigour, being not more than 38 years of age. But he had alſo imbibed in his infancy a deep ſenſe of religion; and this, though it had been ſmothered for a while by his connections with the theatre, and particularly with the famous actreſs Champmelle, whom he greatly loved, and by whom he had a ſon, now at length broke out, and bore down all before it. In the firſt place, he reſolved not only to write no more plays, but to do a rigorous penance for thoſe he had written; and he actually formed a deſign of becoming a Carthuſian friar. His religious director, however, a good deal wiſer than he, adviſed him to think more moderately, and to take meaſures more ſuitable to his character. He put him upon marrying, and ſettling in the world: with which propoſal this humble and tractable penitent complied; and immediately took to wife the daughter of a treaſurer of France for Amiens, by whom he had ſeven children. Racine.

He had been admitted a member of the French academy in 1673, in the room of La Mothe le Vayer deceaſed; but ſpoiled the ſpeech he had made upon that occaſion by pronouncing it with too much timidity. In 1677, he was nominated with Boileau, with whom he was ever in ſtrict friendſhip, to write the hiſtory of Louis XIV.; and the public expected great things from two writers of their diſtinction, but were diſappointed. Boileau and Racine, after having for ſome time laboured at this work, perceived that it was entirely oppoſite to their genius.

He ſpent the latter years of his life in compoſing a hiſtory of the houſe of Port-Royal, the place of his education; which, however, though finely drawn up, as many have aſſerted, has not been publiſhed. Too great ſenſibility, ſay his friends, but more properly an impotence of ſpirit, ſhortened the days of this poet.—Though he had converſed much with the court, he had not learned the wiſdom, which is uſually learned there, of diſguiſing his real ſentiments. Having drawn up a well-reaſoned and well-written memorial upon the miſeries of the people, and the means of relieving them, he one day lent it to Madam de Maintenon to read; when the king coming in, and demanding what and whoſe it was, commended the zeal of Racine, but diſapproved of his meddling with things that did not concern him: and ſaid with an angry tone, "Becauſe he knows how to make good verſes, does he think he knows every thing? And would he be a miniſter of ſtate, becauſe he is a great poet?" Theſe words hurt Racine greatly: he conceived dreadful ideas of the king's diſpleaſure; and his chagrin and fears brought on a fever, of which he died the 22d of April 1699.

The king, who was ſenſible of his great merit, and always loved him, ſent often to him in his illneſs; and finding after his death that he had more glory than riches, ſettled a handſome penſion upon his family.—There is nothing in the French language written with more wit and elegance than his pieces in proſe. Beſides his plays, ſeveral of his letters have been publiſhed; he alſo wrote ſpiritual ſongs, epigrams, &c. Racine's

works

Racing. works were printed at Amſterdam in 1732, in 2 vols 12mo, and the next year a pompous edition was printed in 2 vols quarto.

RACING, the riding heats for a plate, or other premium. See PLATE. The amuſement of horſe-racing, which is now ſo common, was not unknown among the great nations of antiquity, nor wholly unpractiſed by our anceſtors in Britain, as we have already mentioned in the article RACE. In 1599, private matches between gentlemen, who were their own jockies and riders, were very common; and, in the reign of James I. public races were eſtabliſhed at various places, when the diſcipline, and mode of preparing the horſes for running, &c. were much the ſame as they are now. The moſt celebrated races of that time were called bell-courſes, the prize of the conqueror being a bell: hence, perhaps, the phraſe of *bearing the bell*, when applied to excellence, is derived. In the latter end of Charles I.'s reign, races were performed in Hyde-Park. Newmarket was alſo a place for the ſame purpoſe, though it was firſt uſed for hunting. Racing was revived ſoon after the Reſtoration, and much encouraged by Charles II. who appointed races for his own amuſement at Datchet Mead, when he reſided at Windſor. Newmarket, however, now became the principal place. The king attended in perſon, eſtabliſhed a houſe for his own accommodation, and kept and entered horſes in his own name. Inſtead of bells, he gave a ſilver bowl or cup value 100 guineas; on which prize the exploits and pedigree of the ſucceſsful horſe were generally engraved. Inſtead of the cup or bowl, the royal gift is now a hundred guineas, William III. not only added to the plates, but even founded an academy for riding; and Queen Anne continued the bounty of her anceſtors, adding ſeveral plates herſelf. George I. towards the end of his reign, diſcontinued the plates, and gave in their room a hundred guineas. An act was paſſed in the 13th year of the reign of George II. for ſuppreſſing races by poneys and other ſmall and weak horſes, &c. by which all matches for any prize under the value of 50 l. are prohibited, under a penalty of 200 l. to be paid by the owner of each horſe running, and 100 l. by ſuch as advertiſe the plate; and by which each horſe entered to run, if five years old, is obliged to carry ten ſtones; if ſix, eleven; and if ſeven, twelve. It is alſo ordained, that no perſon ſhall run any horſe at a courſe, unleſs it be his own, nor enter more than one horſe for the ſame plate, upon pain of forfeiting the horſes; and alſo every horſe-race muſt be begun and ended in the ſame day. Horſes may run for the value of 50 l. with any weight, and at any place. 13 Geo. II. cap. 19. 18 George II. cap. 34. Pennant's Britiſh Zoology, vol. i. p. 6, &c. Berenger's Hiſtory and Art of Horſemanſhip, vol. i. p. 185, &c. At Newmarket there are two courſes, the long and the round: the firſt is exactly four miles and about 380 yards, *i. e.* 7420 yards. The ſecond is 6640 yards. Childers, the ſwifteſt horſe ever known, has run the firſt courſe in ſeven minutes and a half, and the ſecond in ſix minutes forty ſeconds; which is at the rate of more than forty-nine feet in a ſecond. But all other horſes take up at leaſt ſeven minutes and fifty ſeconds in completing the firſt and longeſt courſe, and ſeven minutes only in the ſhorteſt, which is at the rate of more than forty-ſeven feet in a ſecond. And it is commonly ſuppoſed that theſe courſers cover, at every bound, a ſpace of ground in length about twenty-four Engliſh feet. Race-horſes have been for ſome time an object of taxation. Rachitis, Rack.

RACHITIS, the RICKETS. See MEDICINE, n° 347.

RACK (Edmund), a perſon well known in the literary world by his attachment to, and promotion of, agricultural knowledge: he was a native of Norfolk, a Quaker. His education was common, and he was apprenticed originally to a ſhopkeeper: his ſociety was ſelect in this ſituation, and by improving himſelf in learning, his converſation was enjoyed by a reſpectable acquaintance. He wrote many eſſays, poems, and letters, and ſome few controverſial tracts. At length he ſettled, about his 40th year, at Bath in 1775, and was ſoon introduced to the moſt eminent literati of that place, among whom Dr Wilſon and Mrs Macaulay highly eſteemed him for his integrity and abilities. In 1777 he publiſhed *Mentor's Letters*, a moral work, which has run through many editions. But this year he gained great celebrity by his plan of an agricultural ſociety, which was ſoon adopted by four counties. He ſtill further advanced his fame by his papers in the Farmer's Magazine, and his communications in the Bath Society's papers; a work remarkable for its ingenuity and ſpirit. His laſt engagement was in the Hiſtory of Somerſetſhire, where the topographical parochial ſurveys were his. This work, in 3 vols 4to, was publiſhed in 1791, by his colleague the Reverend Mr Collinſon.—Mr Rack died of an aſthma in February 1787, aged 52.

RACK, an engine of torture, furniſhed with pulleys, cords, &c. for extorting confeſſion from criminals.—The trial by rack is utterly unknown to the law of England; though once, when the dukes of Exeter and Suffolk, and other miniſters of Henry VI. had laid a deſign to introduce the civil law into this kingdom as the rule of government; for a beginning thereof they erected a rack for torture, which was called in deriſion the duke of Exeter's daughter, and ſtill remains in the Tower of London, where it was occaſionally uſed as an engine of ſtate, not of law, more than once in the reign of Queen Elizabeth. But when, upon the aſſaſſination of Villiers duke of Buckingham, by Felton, it was propoſed in the privy council to put the aſſaſſin to the rack, in order to diſcover his accomplices; the judges, being conſulted, declared unanimouſly, to their own honour and the honour of the Engliſh law, that no ſuch proceeding was allowable by the laws of England. It ſeems aſtoniſhing that this uſage of adminiſtering the torture ſhould be ſaid to ariſe from a tenderneſs to the lives of men; and yet this is the reaſon given for its introduction in the civil law, and its ſubſequent adoption by the French and other foreign nations, viz. becauſe the laws cannot endure that any man ſhould die upon the evidence of a falſe, or even a ſingle witneſs, and therefore contrived this method that innocence ſhould manifeſt itſelf by a ſtout denial, or guilt by a plain confeſſion: thus rating a man's virtue by the hardineſs of his conſtitution, and his guilt by the ſenſibility of his nerves. The Marquis Beccaria, in an exquiſite piece of raillery, has propoſed this problem, with a gravity and preciſion that are truly mathematical: "The force of the muſcles and the ſenſibility of the nerves of an innocent perſon being given; it is required to find the degree of pain neceſſary to make him confeſs

confeſs himſelf guilty of a given crime." See *Act of Faith*, INQUISITION, and TORTURE.

RACK, a ſpirituous liquor made by the Tartars of Tonguſla. This kind of rack is made of mare's milk, which is left to be ſour, and afterwards diſtilled twice or thrice between two earthen pots cloſely ſtopped; whence the liquor runs through a ſmall wooden pipe. This liquor is more intoxicating than brandy diſtilled from wine.

RACK, or *Arack*. See ARACK.

To RACK *Wines, &c.* To draw them off from their lees, after having ſtood long enough to ebb and ſettle. Hence rack-vintage is frequently uſed for the ſecond voyage our wine-merchants uſe to make into France for racked wines.

RACKOON, in zoology, a ſpecies of URSUS.

RACONI, a populous town of Italy, in Piedmont, ſeated in a pleaſant plain, on the road from Savillan to Turin, on the rivers Grana and Macra. It belongs to the prince of Carignan, who has a handſome caſtle here. It is ſix miles from Savillan, and ſix from Carignan. E. Long. 7. 46. N. Lat. 44. 39.

RADCLIFFE (Dr John), an Engliſh phyſician of great eminence in his time, born at Wakefield in Yorkſhire in 1650. He was educated at Oxford, and enrolled himſelf upon the phyſical line; but it was remarkable that he recommended himſelf more by his ready wit and vivacity, than by any extraordinary acquiſitions in learning. He began to practiſe at Oxford in 1675; but never paid any regard to eſtabliſhed rules, which he cenſured whenever he thought fit, with great freedom and acrimony; and as this drew all the old practitioners upon him, he lived in a continual ſtate of hoſtility with them. Nevertheleſs, his reputation increaſed with his experience; ſo that, before he had been two years in buſineſs, his practice was very extenſive among perſons of high rank. In 1684 he removed to London, and ſettled in Bow-ſtreet, Covent Garden, where in leſs than a year he got into prime buſineſs.—In 1687 the princeſs Anne of Denmark made him her phyſician: yet when her huſband and ſhe joined the prince of Orange, Radcliffe, either not chooſing to declare himſelf, or unwilling to favour the meaſures then in agitation, excuſed himſelf from attending them, on the plea of the multitude of his patients. Nevertheleſs, he was often ſent for to King William and other great perſonages, though he did not incline to be a courtier. He incurred ſome cenſure for his treatment of Q. Mary, who died of the ſmall-pox; and ſoon after loſt his place about the princeſs Anne, by his attachment to his bottle. He alſo totally loſt the favour of K. William by his uncourtly freedom; for, in 1699, when the king ſhowed him his ſwollen ankles, while the reſt of his body was emaciated, and aſked him what he thought of them? "Why truly I would not have your majeſty's two legs for your three kingdoms," replied Radcliffe. He continued increaſing in buſineſs and inſolence as long as he lived, continually at war with his brethren the phyſicians; who conſidered him in no other light than that of an active ingenious empiric, whom conſtant practice had at length brought to ſome degree of ſkill in his profeſſion. He died in 1714; and if he never attempted to write any thing himſelf, has perpetuated his memory by founding a fine library at Oxford, to preſerve the writings of other men.

RADIALIS, the name of two muſcles in the arm. See ANATOMY, *Table of the Muſcles*.

RADIANT, in optics, is any point of a viſible object from whence rays proceed.

RADIATED FLOWERS, in botany, are ſuch as have ſeveral ſemifloſcules ſet round a diſk, in form of a radiant ſtar; thoſe which have no ſuch rays are called *diſcous flowers*.

RADIATION, the act of a body emitting or diffuſing rays of light all round as from a centre.

RADICAL, in general, ſomething that ſerves as a baſis or foundation. Hence phyſicians talk much of a radical moiſture. In grammar, we give the appellation *radical* to primitives, in contradiſtinction to compounds and derivatives. Algebraiſts alſo ſpeak of the radical ſign of quantities, which is the character expreſſing their roots.

RADICLE, that part of the ſeeds of all plants which upon vegetating becomes their root, and is diſcoverable by the microſcope. See PLANT.

RADISH, in botany. See RAPHANUS.

RADIUS, in geometry, the ſemidiameter of a circle, or a right line drawn from the centre to the circumference.

In trigonometry, the radius is termed the whole ſine, or ſine of 90°. See SINE.

RADIUS, in anatomy, the exterior bone of the arm, deſcending along with the ulna from the elbow to the wriſt.

RADNOR, the county-town of Radnorſhire, in South Wales. It is a poor little place, diſtant from London about 150 miles. It is ſituated near the ſpring-head of the river Somergil, in a fruitful valley at the bottom of a hill, where there are ſheep grazing in abundance. It is a very ancient borough-town, whoſe juriſdiction extends near 12 miles round about: the government of it is veſted in a bailiff and 25 burgeſſes. Though it is the county-town, the aſſizes are held at Preſteign: it has one privilege, however, that is very extraordinary, beſides that of ſending one member to parliament; and that is, it keeps a court of pleas for all actions, without being limited to any particular ſum. It was formerly fenced with a wall and a ſtrong caſtle; but both were in a great meaſure demoliſhed by Owen Glendower, when he aſſumed the title of Prince of Wales, upon the depoſition of King Richard II. W. Long. 2. 45. N. Lat. 52. 10.

RADNORSHIRE, a county of South Wales, is bounded on the north by Montgomeryſhire; on the eaſt by Shropſhire and Herefordſhire; on the ſouth and ſouth-weſt by Brecknockſhire; and on the weſt by Cardiganſhire; extending 30 miles in length and 25 in breadth. This county is divided into ſix hundreds, in which are contained three market-towns, 52 pariſhes, about 3160 houſes, and 18,960 inhabitants. It is ſeated in the dioceſe of Hereford, and ſends two members to parliament, one for the county and one for the town of Radnor. The air of this county is in winter cold and piercing. The ſoil in general is but indifferent; yet ſome places produce corn, particularly the eaſtern and ſouthern parts; but in the northern and weſtern, which are mountainous, the land is chiefly ſtocked with horned cattle, ſheep, and goats.

RADIX. See ROOT.

RAFT, a ſort of float, formed by an aſſemblage of various

Rafters || Raguſa.

various planks or pieces of timber, faſtened together ſide by ſide, ſo as to be conveyed more commodiouſly to any ſhort diſtance in a harbour or road than if they were ſeparate. The timber and plank with which merchant-ſhips are laden, in the different parts of the Baltic Sea, are attached together in this manner, in order to float them off to the ſhipping,

RAFTERS, in building, are pieces of timber which, ſtanding by pairs on the reaſon or railing piece, meet in an angle at the top, and form the roof of a building. See ARCHITECTURE.

ROWLEY RAGG, a genus of ſtones, belonging to the ſiliceous claſs. It is of a duſky or dark grey colour, with many ſmall ſhining cryſtals, having a granular texture, and acquiring an ochry cruſt by expoſure to the air. The ſpecific gravity is 2748. It becomes magnetic by being heated in an open fire. In a ſtrong fire it melts without addition, but with more difficulty than baſaltes. It was analyſed by Dr Withering, who found that 100 parts of it contain 47.5 of ſiliceous earth, 32.5 of argil, and 20 of iron.

RAGMAN's ROLL, Rectius Ragimund's roll, ſo called from one Ragimund a legate in Scotland, who calling before him all the beneficed clergymen in that kingdom, cauſed them on oath to give in *the true value* of their benefices; according to which they were afterwards taxed by the court of Rome; and this roll, among other records, being taken from the Scots by Edward I. was redelivered to them in the beginning of the reign of Edward III.

RAGOUT, or RAGOO, a ſauce, or ſeaſoning, intended to rouſe the appetite when loſt or languiſhing.

This term is alſo uſed for any high-ſeaſoned diſh prepared of fleſh, fiſh, greens, or the like: by ſtewing them with bacon, ſalt, pepper, cloves, and the like ingredients. We have ragouts of celery, of endive, aſparagus, cock's combs, giblets, craw-fiſh, &c.

The ancients had a ragout called *garum*, made of the putrified guts of a certain fiſh kept till it diſſolved into a mere ſanies, which was thought ſuch a dainty, that, according to Pliny, its price equalled that of the richeſt perfumes.

RAGSTONE, a genus of ſtones belonging to the claſs of ſiliceous earths. It is of a grey colour; the texture obſcurely laminar, or rather fibrous; but the laminæ or fibres conſiſt of a congeries of grains of a quartzy appearance, coarſe and rough. The ſpecific gravity is 2729; it effervesces with acids, and ſtrikes fire with ſteel. Mr Kirwan found it to contain a portion of mild calareous earth, and a ſmall proportion of iron. It is uſed as a whetſtone for coarſe cutting tools. It is found about Newcaſtle, and many other parts of England, where there are large rocks of it in the hills.

RAGULED, or RAGGED, in heraldry, jagged or knotted. This term is applied to a croſs formed of the trunks of two trees without their branches, of which they ſhow only the ſtumps. *Raguled* differs from *indented*, in that the latter is regular, the former not.

RAGUSA, an ancient town of Sicily, in the Val-di-Noto, near the river Maulo, 12 miles north of Modica. E. Long. 14. 59. N. Lat. 37. 0.

RAGUSA, a city of Dalmatia, and capital of Raguſen. It is about two miles in circumference, is pretty well built, and ſtrong by ſituation, having an inacceſſible mountain on the land-ſide, and on the ſide of the ſea a ſtrong fort. It has an archbiſhop's ſee and a republic, and has a doge like that of Venice, but he continues a month only in his office. It carries on a conſiderable trade with the Turks, and is 60 miles north-weſt of Scutari, and 110 north of Brindiſi. E. Long. 18. 10. N. Lat. 42. 50.

Raguſen, Raja.

RAGUSEN, a territory of Europe in Dalmatia, lying along the coaſt of the gulph of Venice, about 55 miles in length, and 20 in breadth. It is a republic under the protection of the Turks and Venetians. Raguſa is the capital town.

RAJA, the title of the Indian black princes, the remains of thoſe who ruled there before the Moguls. Some of the rajas are ſaid to preſerve their independency, eſpecially in the mountainous parts; but moſt of them pay an annual tribute to the Mogul. The Indians call them *rai*; the Perſians, *raian*, in the plural; and our travellers *rajas*, or *ragias*.

RAJA, the *Ray-Fiſh*, in ichthyology; a genus belonging to the order of Chondropterygia. There are five ſpiracula below towards the peak; the body compreſſed; and the mouth is ſituated under the head. The moſt remarkable ſpecies are,

1. The batis, or ſkate: this ſpecies is the thinneſt in proportion to its bulk of any of the genus, and alſo the largeſt, ſome weighing near 200 pounds. The noſe, though not long, is ſharp pointed; above the eyes is a ſet of ſhort ſpines: the upper part is of a pale brown, ſometimes ſtreaked with black: the lower part is white, marked with great numbers of minute black ſpots. The jaws are covered with ſmall granulated but ſharp-pointed teeth. The tail is of a moderate length: near the end are two fins: along the top of it is one row of ſpines, and on the edges are irregularly diſperſed a few others, which makes us imagine with Mr Ray, that in this reſpect theſe fiſh vary, ſome having one, others more orders of ſpines on the tail. It is remarked, that in the males of this ſpecies the fins are full of ſpines. Skates generate in March and April; at which time they ſwim near the ſurface of the water, ſeveral of the males purſuing one female. They adhere ſo faſt together in coition, that the fiſhermen frequently draw up both together, though only one has taken the bait. The females begin to caſt their *purſes*, as the fiſhermen call them (the bags in which the young are included) in May, and continue doing it till September. In October they are exceedingly poor and thin; but in November they begin to improve, and grow gradually better till May, when they are in the higheſt perfection. The males go ſooner out of ſeaſon than the females.

2. The oxyrinchus, or ſharp-noſed ray, in length near ſeven feet, and breadth five feet two inches; when juſt brought on ſhore, it makes a remarkable ſnorting noiſe. The noſe is very long, narrow, and ſharp-pointed, not unlike the end of a ſpontoon. The body is ſmooth, and very thin in proportion to the ſize; the upper part aſh-coloured, ſpotted with numerous white ſpots, and a few black ones. The tail is thick; towards the end are two ſmall fins; on each ſide is a row of ſmall ſpines, with another row in the middle, which runs ſome way up the back. The lower part of the fiſh is quite white. The mouth is very large, and furniſhed with numbers of ſmall ſharp teeth bending inwards. This fiſh has been ſuppoſed to be the *bos* of the ancients;

Raja.

ents; which was certainly ſome enormous ſpecies of ray, though we cannot pretend to determine the particular kind. Oppian ſtyles it, *the broadeſt among fiſhes:* he adds an account of its fondneſs of human fleſh, and the method it takes of deſtroying men, by over-laying and keeping them down by its vaſt weight till they are drowned. Phile *(De propriet. anim.* p. 85.) gives much the ſame relation. We are inclined to give them credit, ſince a modern writer, of undoubted authority *, gives the very ſame account of a fiſh found in the South Seas, the terror of thoſe employed in the pearl-fiſhery. It is a ſpecies of ray, called there *manta*, or the *quilt*, from its ſurrounding and wrapping up the unhappy divers till they are ſuffocated; therefore the negroes never go down without a ſharp knife to defend themſelves againſt the aſſaults of this terrible enemy.

* Ulloa's Voyage, L. 132.

3. The aſpera, or rough ray, is found in Loch-Broom in Scotland. The length from the noſe to the tip of the tail is two feet nine. The tail is almoſt of the ſame length with the body. The noſe is very ſhort. Before each eye is a large hooked ſpine; and behind each another, beſet with leſſer. The upper part of the body is of a cinereous brown mixed with white, and ſpotted with black; and entirely covered with ſmall ſpines. On the tail are three rows of great ſpines: all the reſt of the tail is irregularly beſet with leſſer. The fins and under ſide of the body are equally rough with the upper. The teeth are flat and rhomboidal.

4. The fullonica, or fuller, derives its Latin name from the inſtrument fullers make uſe of in ſmoothing cloth, the back being rough and ſpiney. The noſe is ſhort and ſharp. At the corner of each eye are a few ſpines. The membrane of nictitation is fringed. Teeth ſmall and ſharp. On the upper part of the pectoral fins are three rows of ſpines pointing towards the back, crooked like thoſe on a fuller's inſtrument. On the tail are three rows of ſtrong ſpines: the middle row reaches up part of the back. The tail is ſlender, and rather longer than the body. The colour of the upper part of the body is cinereous, marked uſually with numerous black ſpots: the lower part is white. This, as well as moſt other ſpecies of rays, vary a little in colour, according to age. This grows to a ſize equal to the ſkate. It is common at Scarborough, where it is called the *white hans*, or *gullet*.

5. The ſhagreen ray increaſes to the ſize of the ſkate; is fond of launces or ſand-eels, which it takes generally as a bait. The form is narrower than that of the common kinds; the noſe long and very ſharp; pupil of the eye ſapphirine; on the noſe are two ſhort rows of ſpines; on the corner of the eyes another of a ſemicircular form; on the tail are two rows, continued a little up the back, ſmall, ſlender, and very ſharp: along the ſides of the tail is a row of minute ſpines, intermixed with innumerable little ſpiculæ. The upper part of the body is of a cinereous brown, covered cloſely with ſhagreen-like tubercles, reſembling the ſkin of the dog-fiſh: the under ſide of the body is white; from the noſe to the beginning of the pectoral fins is a tuberculated ſpace. The teeth ſlender, and ſharp as needles.

6. The torpedo, cramp-fiſh, or electric ray, is frequently taken in Torbay: has been once caught off Pembroke, and ſometimes near Waterford in Ireland. It is generally taken, like other flat fiſh, with the trawl; but there is an inſtance of its taking the bait. It commonly lies in water of about 40 fathoms depth; and in company with the congenerous rays. The torpedo brings forth its young at the autumnal equinox, as affirmed by Ariſtotle. A gentleman of La Rochelle, on diſſecting certain females of this ſpecies, the 10th of September, found in the matrices ſeveral of the fœtuſes quite formed, and nine eggs in no ſtate of forwardneſs: ſuperfœtation ſeems therefore to be a property of this fiſh. The food of the torpedo is fiſh; a ſurmullet and a plaiſe have been found in the ſtomach of two of them. The ſurmullet is a fiſh of that ſwiftneſs, that it was impoſſible for the torpedo to take it by purſuit. It is probable, therefore, that by their electric ſtroke they ſtupify their prey; yet the crab and ſea-leech will venture to annoy them. They will live 24 hours out of the ſea; and but very little longer if placed in freſh water. They inhabit ſandy places; and will bury themſelves ſuperficially in it, by flinging the ſand over, by a quick flapping of all the extremities. It is in this ſituation that the torpedo gives his moſt forcible ſhock, which throws down the aſtoniſhed paſſenger who inadvertently treads upon him. In our ſeas it grows to a great ſize, and above 80 pounds weight. The tail is thick and round; the caudal fin broad and abrupt. The head and body, which are indiſtinct, are nearly round; attenuating to extreme thinneſs on the edges; below the body, the ventral fins form on each ſide a quarter of a circle. The two dorſal fins are placed on a trunk of the tail. The eyes are ſmall, placed near each other: behind each is a round ſpiracle, with ſix ſmall cutaneous rags on their inner circumference. Mouth ſmall; teeth minute, ſpicular. Five openings to the gills, as in others of this genus. The ſkin everywhere ſmooth; cinereous brown above, white beneath. See further the article ELECTRICITY, n° 258—261.

7. The clavata, or thornback, is eaſily diſtinguiſhed from the others by the rows of ſtrong ſharp ſpines diſpoſed along the back and tail. In a large one ſeen by Mr Pennant, were three rows on the back, and five on the tail, all inclining towards its end. On the noſe, and on the inner ſide of the forehead, near the eyes, were a few ſpines, and others were ſcattered without any order on the upper part of the pectoral fins. The mouth was ſmall, and filled with granulated teeth: The upper part of the body was of a pale aſh colour, marked with ſhort ſtreaks of black, and the ſkin rough, with ſmall tubercles like ſhagreen. The belly white, croſſed with a ſtrong ſemilunar cartilage beneath the ſkin: in general, the lower part was ſmooth, having only a few ſpines on each ſide. The young fiſh have very few ſpines on them; and their backs are often ſpotted with white, and each ſpot is encircled with black. This ſpecies frequents our ſandy ſhores; are very voracious, and feed on all ſorts of flat fiſh; are particularly fond of herrings and ſand-eels; and ſometimes eat cruſtaceous animals, ſuch as crabs. Theſe ſometimes weigh 14 or 15 pounds, but with us ſeldom exceed that weight. They begin to generate in June, and bring forth their young in July and Auguſt, which (as well as thoſe of the ſkate) before they are old enough to breed, are called *maids*. The thornback begins to be in ſeaſon in November, and continues ſo later than the ſkate, but the young of both are good at all times of the year.

8. The paſtinaca, or ſting ray, does not grow to the bulk of the others: The body is quite ſmooth, of ſhape almoſt round, and is of a much greater thickneſs and

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more elevated form in the middle than any other rays, but grows thin towards the edges. The noſe is very ſharp pointed, but ſhort; the mouth ſmall, and filled with granulated teeth. The irides are of a gold colour: behind each eye the orifice is very large. The tail is very thick at the beginning: the ſpine is placed about a third the length of the former from the body; is about five inches long, flat on the top and bottom, very hard, ſharp pointed, and the two ſides thin, and cloſely and ſharply bearded the whole way. The tail extends four inches beyond the end of this ſpine, and grows very ſlender at the extremity. Theſe fiſh are obſerved to ſhed their ſpine, and renew them annually; ſometimes the new ſpine appears before the old one drops off; and the Corniſh call this ſpecies *cardinal triloſt*, or *three-tailed*, when ſo circumſtanced. The colour of the upper part of the body is a dirty yellow, the middle part of an obſcure blue: the lower ſide white, the tail and ſpine duſky. The weapon with which nature has armed this fiſh, hath ſupplied the ancients with many tremendous fables relating to it. Pliny, Ælian, and Oppian, have given it a venom that affects even the inanimate creation: trees that are ſtruck by it inſtantly loſe their verdure and periſh, and rocks themſelves are incapable of reſiſting the potent poiſon. The enchantreſs Circe armed her ſon with a ſpear headed with the ſpine of the trygon, as the moſt irreſiſtible weapon ſhe could furniſh him with; and with which he afterwards committed parricide, unintentionally, on his father Ulyſſes. That ſpears and darts might, in very early times, have been headed with this bone inſtead of iron, we have no kind of doubt; that of another ſpecies of this fiſh being ſtill uſed to point the arrows of ſome of the South American Indians, and is, from its hardneſs, ſharpneſs, and beards, a moſt dreadful weapon. But in reſpect to its venomous qualities, there is not the leaſt credit to be given to the opinion, though it was believed (as far as it affected the animal world) by Rondeletius, Aldrovand, and others, and even to this day by the fiſhermen in ſeveral parts of the kingdom. It is in fact the weapon of offence belonging to the fiſh, capable of giving a very bad wound, and which is attended with dangerous ſymptoms when it falls on a tendinous part or on a perſon in a bad habit of body. As to any fiſh having a ſpine charged with actual poiſon, it ſeems very dubious, though the report is ſanctified by the name of Linnæus. He inſtances the *paſtinaca*, the *torpedo*, and the *tetrodon lineatus*. The firſt is incapable of conveying a greater injury than what reſults from the mere wound; the ſecond, from its electric effluvia; and the third, by imparting a pungent pain like the ſting of nettles, occaſioned by the minute ſpines on its abdomen.

RAIANIA, in botany: A genus of the hexandria order, belonging to the dioecia claſs of plants; and in the natural method ranking under the 11th order, *Sarmentaceæ*. The male calyx is ſexpartite; there is no corolla. The female calyx as in the male, without any corolla; there are three ſtyles; the fruit is roundiſh with an oblique wing, inferior. There are three ſpecies, the haſtata, cordata, and quinquefolia.

RAIETEA, one of the South Sea iſlands, named alſo ULIETEA.

RAIL, in ornithology. See RALLUS.

RAILLERY, according to Dr Johnſon, means ſlight ſatire, or ſatirical merriment; and a beautiful writer of the laſt century compares it to a light which dazzles, and which does not burn. It is ſometimes innocent and pleaſant, and it ſhould always be ſo, but it is moſt frequently offenſive. Raillery is of various kinds; there is a ſerious, ſevere, and good-humoured raillery; and there is a kind which perplexes, a kind which offends, and a kind which pleaſes. Rain.

To rally well, it is abſolutely neceſſary that kindneſs run through all you ſay; and you muſt ever preſerve the character of a friend to ſupport your pretenſions to be free with a man. Alluſions to paſt follies, hints to revive what a man has a mind to forget for ever, ſhould never be introduced as the ſubjects of raillery. This is not to thruſt with the ſkill of fencers, but to cut with the barbarity of butchers. But it is below the character of men of humanity and good-breeding to be capable of mirth, while there is any in the company in pain and diſorder.

RAIN, the deſcent of water from the atmoſphere in the form of drops of a conſiderable ſize. By this circumſtance it is diſtinguiſhed from dew and fog: in the former of which the drops are ſo ſmall that they are quite inviſible; and in the latter, though their ſize is larger, they ſeem to have very little more ſpecific gravity than the atmoſphere itſelf, and may therefore be reckoned hollow ſpherules rather than drops.

It is univerſally agreed, that rain is produced by the water previouſly abſorbed by the heat of the ſun, or otherwiſe, from the terraqueous globe, into the atmoſphere; but very great difficulties occur when we begin to explain why the water, once ſo cloſely united with the atmoſphere, begins to ſeparate from it. We cannot aſcribe this ſeparation to cold, ſince rain often takes place in very warm weather; and though we ſhould ſuppoſe the condenſation owing to the ſuperior cold of the higher regions, yet there is a remarkable fact which will not allow us to have recourſe to this ſuppoſition. It is certain that the drops of rain increaſe in ſize conſiderably as they deſcend. On the top of a hill, for inſtance, they will be ſmall and inconſiderable, forming only a drizzling ſhower; but at the bottom of the ſame hill the drops will be exceſſively large, deſcending in an impetuous rain; which ſhows that the atmoſphere is diſpoſed to condenſe the vapours, and actually does ſo, as well where it is warm as where it is cold.

For ſome time the ſuppoſitions concerning the cauſe of rain were exceedingly inſufficient and unſatisfactory. It was imagined, that when various congeries of clouds were driven together by the agitation of the winds, they mixed, and run into one body, by which means they were condenſed into water. The coldneſs of the upper parts of the air alſo was thought to be a great means of collecting and condenſing the clouds into water; which, being heavier than the air, muſt neceſſarily fall down through it in the form of rain. The reaſon why it falls in drops, and not in large quantities, was ſaid to be the reſiſtance of the air; whereby being broken, and divided into ſmaller and ſmaller parts, it at laſt arrives to us in ſmall drops. But this hypotheſis is entirely contrary to almoſt all the phenomena: for the weather, when coldeſt, that is, in the time of ſevere froſt, is generally the moſt ſerene; the moſt violent rains alſo happen where there is little or no cold to condenſe the clouds; and the drops of rain, inſtead of being divided into ſmaller and ſmaller ones as they approach the earth, are plainly increaſed in ſize as they deſcend.

Dr

Rain.

Dr Derham accounted for the precipitation of the drops of rain from the veſiculæ being full of air, and meeting with an air colder than they contained, the air they contained was of conſequence contracted into a ſmaller ſpace; and conſequently the watery ſhell rendered thicker, and thus ſpecifically heavier, than the common atmoſphere. But it has been ſhown, that the veſiculæ, if ſuch they are, of vapour, are not filled with air, but with fire, or heat; and conſequently, till they part with this latent heat, the vapour cannot be condenſed §. Now, cold is not always ſufficient to effect this, ſince in the moſt ſevere froſts the air is very often ſerene, and parts with little or none of its vapour for a very conſiderable time. Neither can we admit the winds to have any conſiderable agency in this matter, ſince we find that blowing upon vapour is ſo far from condenſing it, that it unites it more cloſely with the air, and wind is found to be a great promoter of evaporation.

§ See *Chemiſtry*, n° 224, &c.

According to Rohault, the great cauſe of rain is the heat of the air; which, after continuing for ſome time near the earth, is raiſed on high by a wind, and there thawing the ſnowy villi or flocks of half-frozen veſiculæ, reduces them to drops; which, coaleſcing, deſcend. Here, however, we ought to be informed by what means theſe veſiculæ are ſuſpended in their half-frozen ſtate; ſince the thawing of them can make but little difference in their ſpecific gravity, and it is certain that they aſcended through the air not in a frozen but in an aqueous ſtate.

Dr Clarke and others aſcribe this deſcent of the rain rather to an alteration of the atmoſphere than of the veſiculæ; and ſuppoſe it to ariſe from a diminution of the elaſtic force of the air. This elaſticity, which, they ſay, depends chiefly or wholly upon terrene exhalations, being weakened, the atmoſphere ſinks under its burden, and the clouds fall. Now, the little veſicles being *once* upon the deſcent, will continue therein, notwithſtanding the increaſe of reſiſtance they every moment meet with. For, as they all tend to the centre of the earth, the farther they fall, the more coalitions they will make; and the more coalitions, the more matter will there be under the ſame ſurface; the ſurface increaſing only as the ſquares, but the ſolidity as the cubes; and the more matter under the ſame ſurface, the leſs reſiſtance will there be to the ſame matter. Thus, if the cold, wind, &c. act early enough to precipitate the aſcending veſicles before they are arrived at any conſiderable height, the coalitions being but few, the drops will be proportionably ſmall; and thus is formed a dew. If the vapours be more copious, and riſe a little higher, we have a miſt or fog. A little higher ſtill, and they produce a ſmall rain; if they neither meet with cold nor wind, they form a heavy thick dark ſky. This hypotheſis is equally unſatisfactory with the others; for, granting that the deſcent and condenſation of the vapours are owing to a diminution of the atmoſphere's elaſticity, by what is this diminution occaſioned? To ſay that it is owing to terrene exhalations, is only ſolving one difficulty by another; ſince we are totally unacquainted both with the nature and operation of theſe exhalations. Beſides, let us ſuppoſe the cauſe to be what it will, if it acts equally and at once upon all the vapour in the air, then all that vapour muſt be precipitated at once; and thus, inſtead of gentle ſhowers continuing for a conſiderable length of time, we ſhould have the moſt violent waterſpouts, continuing only for a few minutes, or perhaps ſeconds, which, inſtead of refreſhing the earth, would drown and lay waſte every thing before them.

Rain.

Since philoſophers have admitted the electric fluid to ſuch a large ſhare in the operations of nature, almoſt all the natural phenomena have been accounted for by the action of that fluid; and rain, among others, has been reckoned an effect of electricity. But this word, unleſs it is explained, makes us no wiſer than we were before; the phenomena of artificial electricity having been explained on principles which could ſcarce apply in any degree to the electricity of nature: and therefore all the ſolution we can obtain of the natural appearances of which we ſpeak, comes to this, that rain is occaſioned by a moderate electrification, hail and ſnow by one more violent, and thunder by the moſt violent of all; but in what manner this electrification is occaſioned, hath not yet been explained. Throughout the various parts of this work where electricity hath been occaſionally mentioned, the principles of artificial electricity ‖, laid down in the treatiſe appropriated to that ſubject, have been applied to the ſolution of the phenomena of nature; thoſe which are neceſſary to be attended to here are the following:

‖ See *Electricity*, n° 201, 210, &c.

1. The electric fluid and ſolar light are the ſame ſubſtance in two different modifications.

2. Electricity is the motion of the fluid when running, or attempting to run, in a continued ſtream from one place to another: heat is when the fluid has no tendency but to vibrate outwards and inwards to and from a centre; or at leaſt when its ſtreams converge to a point or focus.

3. The fluid acting as electricity, like water, or any other fluid, always tends to the place where there is leaſt reſiſtance.

On theſe three principles may the phenomena of atmoſpherical electricity, and the deſcent of rain by its means, be explained as follows:

1. The light or heat of the ſun, acting in that peculiar manner which we call *heat*, unites itſelf with the moiſture of the earth, and forms it into vapour, which thus becomes ſpecifically lighter than air, and of conſequence aſcends in the atmoſphere to a certain height.

2. Beſides the quantity of light which is thus united to the water, and forms it into vapour, a very conſiderable quantity enters the earth, where it aſſumes the nature of electric fluid.

3. As the earth is always full of that fluid, every quantity which enters muſt diſplace an equal quantity which is already there.

4. This quantity which is diſplaced muſt eſcape either at a diſtance from the place where the other enters, or very near it.

5. At whatever place a quantity of electric matter eſcapes, it muſt electrify the air above that place where it has eſcaped; and as a conſiderable quantity of light muſt always be reflected from the earth into the atmoſphere, where it does not combine with the aqueous vapour, we have thence another ſource of electricity to the air; as this quantity muſt undoubtedly aſſume the action of electric fluid, eſpecially after the action of the ſun has ceaſed. Hence the rea-

Rain. ſon why in ſerene weather the atmoſpherical electricity is always ſtrongeſt, and rather more ſo in the night than in the day.

6. From theſe conſiderations, we ſee an evident reaſon why there muſt commonly be a difference between the electricity of the earth and that of the atmoſphere, excepting when an earthquake is about to enſue. The conſequence of this muſt be, that as the action of the ſolar light continues to bring down the electric matter, and the earth continues to diſcharge an equal quantity of it into the atmoſphere, ſome part of the atmoſphere muſt at laſt become overloaded with it, and attempt to throw it back into the earth. This attempt will be vain, until a vent is found for the electricity at ſome other place; and as ſoon as this happens, the electrified atmoſphere begins to throw off its ſuperfluous electricity, and the earth to receive it. As the atmoſphere itſelf is a bad conductor, and the more ſo the drier it is, the electric matter attacks the ſmall aqueous particles which are detained in it by means of the latent heat. Theſe being unable to bear the impetus of the fluid, throw out their latent heat, which eaſily eſcapes, and thus makes a kind of vacuum in the electrified part of the atmoſphere. The conſequences of this are, that the aqueous particles being driven together in large quantity, at laſt become viſible, and the ſky is covered with clouds; at the ſame time a wind blows againſt theſe clouds, and, if there is no reſiſtance in the atmoſphere, will drive them away.

7. But if the atmoſphere all round the cloud is exceedingly electrified, and the earth is in no condition to receive the ſuperfluous fluid excepting in that place which is directly under the cloud, then the whole electricity of the atmoſphere for a vaſt way round will tend to that part only, and the cloud will be electrified to an extreme degree. A wind will now blow againſt the cloud from all quarters, more and more of the vapour will be extricated from the air by the electric matter, and the cloud will become darker and thicker, at the ſame time that it is in a manner ſtationary, as being acted upon by oppoſite winds; though its ſize is enlarged with great rapidity by the continual ſupplies of vapour brought by the winds.

8. The vapours which were formerly ſuſpended inviſibly by means of the latent heat are now ſuſpended viſibly by the electric fluid, which will not let them fall to the earth, until it is in a condition to receive the electric matter deſcending with the rain.—It is eaſy to ſee, however, that thus every thing is prepared for a violent ſtorm of thunder and lightning as well as rain. The ſurface of the earth becomes electrified from the atmoſphere: but when this has continued for ſome time, a zone of earth conſiderably below the ſurface acquires an electricity oppoſite to that of the clouds and atmoſphere; of conſequence the electricity in the cloud being violently preſſed on all ſides, will at laſt burſt out towards that zone where the reſiſtance is leaſt, as explained under the article LIGHTNING.—The vapours now having loſt that which ſupported them, will fall down in rain, if there is not a ſufficient quantity of electric matter to keep them in the ſame ſtate in which they were before: but if this happens to be the caſe, the cloud will inſtantly be charged again, while little or no rain will fall; and hence very violent thunder ſometimes takes place without any rain at all, or ſuch as is quite inconſiderable in quantity. Rain.

9. When the electricity is leſs violent, the rain will deſcend in vaſt quantity, eſpecially after every flaſh of lightning; and great quantities of electric matter will thus be conveyed to the earth, inſomuch that ſometimes the drops have been obſerved to ſhine as if they were on fire, which has given occaſion to the reports of fiery rain having fallen on certain occaſions. If the quantity of electric matter is ſmaller, ſo that the rain can convey it all gradually to the ground, there will be rain without any thunder; and the greater the quantity of electricity the more violent will be the rain.

From this account of the cauſes of rain, we may ſee the reaſon why in warm climates the rains are exceſſive, and for the moſt part accompanied with thunder; for there the electricity of the atmoſphere is immenſely greater than it is with us. We may alſo ſee why in certain places, according to the ſituation of mountains, ſeas, &c. the rains will be greater than in others, and likewiſe why ſome parts of the world are exempted from rain altogether; but as a particular diſcuſſion of theſe would neceſſarily include an explanation of the cauſes and phenomena of THUNDER, we ſhall for this reaſon refer the whole to be treated of under that article.

Whether this theory be juſt, however, it would be too aſſuming in us to ſay. It may admit of diſpute, for we muſt grant that in the very beſt ſyſtems, though an occurrence ſo frequent, the theory of rain is but very imperfectly underſtood. Dr James Hutton, Fellow of the Royal Society of Edinburgh, whoſe ſpeculations are always ingenious, though generally extraordinary, and much out of the common way, gives us a new theory of rain in the firſt volume of the Tranſactions of that ſociety. It is well known that atmoſpheric air is capable of diſſolving, with a certain degree of heat, a given quantity of water. The Doctor aſcertains the ratio of the diſſolving power of air, in relation to water, in different degrees of heat; and ſhows, that by mixing a portion of tranſparent humid warm air with a portion of cold air, the mixture becomes opake, and part of the water will be precipitated; or, in other words, the vapour will be condenſed into rain. The ratio which he ſtates, however, does not appear to us to be ſupported by experience. Whether the electricity of the air changes in conſequence of its depoſiting the water diſſolved in it, or the change is a cauſe of this depoſition, muſt remain uncertain; but, in either view, there muſt be an agent different from heat and cold, ſince the changes in theſe reſpects do not in other operations change the ſtate of electricity. Dr Hutton ſuppoſes that heat and ſolution do not increaſe by equal increments; but that, in reality, if heat be ſuppoſed to increaſe by equal increments along a ſtraight line, ſolution will be expreſſed by ordinates to a curve whoſe convex ſide is turned towards that line. That the power of ſolution is not increaſed in the ſame ratio with heat, is, however, hypothetical, except when we riſe pretty high in the ſcale, when its proportional increaſe is a little doubtful; and it is not, in this paper, ſupported by experiment. The condenſation of the breath in air is not an obſervation in point, except in air already ſaturated with vapour. It can amount, in any view, to no more than this, that to render it viſible, the heat muſt be diminiſhed

Rain. miniſhed in a greater proportion than can be compenſated by the power of ſolution in the body of air, in which the portion expired is at firſt immerſed. To explain rain from this cauſe, we muſt always ſuppoſe a conſtant diminution of heat to take place at the moment of the condenſation of the vapour; but we actually find that the change from a ſtate of vapour to the fluid ſtate is attended with heat; ſo that rain muſt at once oppoſe its own cauſe, and continued rains would be impoſſible, without calling in the aid of other cauſes. From his own ſyſtem, Dr Hutton endeavours to explain the regular and irregular ſeaſons of rain, either reſpecting the generality of its appearance, or the regularity of its return. And to obviate the apparent exceptions of the theory, from the generality of rain, he explains the proportional quantities of rain, and adds a comparative eſtimate of climates, in relation to rain, with the meteorological obſervations made in our own climate. As his principle is at leaſt inſufficient, and we think erroneous, it would be uſeleſs, even were this a proper place for it, to purſue theſe various branches, which muſt partake of the errors of the ſyſtem. In theſe branches we ought to obſerve, that there are ſeveral juſt obſervations, mixed with errors, becauſe evaporation and condenſation muſt at laſt be the great baſis of every theory: the miſtakes ariſe from not being aware of all the cauſes, and miſrepreſenting the operation of thoſe which do exiſt.

In a work entitled Thoughts on Meteorology, Volume II. M. de Luc conſiders very particularly the grand phenomenon of rain, and the numerous circumſtances connected with it. He examines the ſeveral hypotheſes with conſiderable care; but thinks them, even if admiſſible, utterly inſufficient to account for the formation of rain. The grand queſtion in this inquiry is, What becomes of the water that riſes in vapour into the atmoſphere? or what ſtate it ſubſiſts in there, between the time of its evaporation and its falling down again in rain? If it continues in the ſtate of watery vapour, or ſuch as is the immediate product of evaporation, it muſt poſſeſs the diſtinctive characters eſſential to that fluid: it muſt make the hygrometer move towards humidity, in proportion as the vapour is more or leſs abundant in the air: on a diminution of heat, the humidity, as ſhown by the hygrometer, muſt increaſe; and on an increaſe of the heat the humidity muſt diminiſh; and the introduction of other hygroſcopic ſubſtances, drier than the air, muſt have the ſame effect as an augmentation of heat. Theſe are the properties of watery vapour, on every hypotheſis of evaporation; and therefore all the water that exiſts in the atmoſphere without poſſeſſing theſe properties, is no longer vapour, but muſt have changed its nature. M. de Luc ſhows, that the water which forms rain, though it has ever been conſidered and reaſoned upon as producing humidity, does not poſſeſs theſe properties, and muſt therefore have paſſed into another ſtate. See a full account of his reaſoning, and the ſteps by which he proceeded, in the article METEOROLOGY, n° 7, &c. As he thinks that the vapour paſſes into an inviſible ſtate in the interval between evaporation and its falling again in rain, and that in that ſtate it is not ſenſible to the hygrometer, he conſiders the laws of hygrology as inſufficient for explaining the formation of rain; but he does not pretend to have diſcovered the immediate cauſe of the formation of clouds and rain. If it is not in the immediate product of evaporation that rain has its ſource; if the vapours change their nature in the atmoſphere, ſo as no longer to be ſenſible to the hygrometer, or to the eye; if they do not become vapour again till clouds appear; and if, when the clouds are formed, no alteration is perceived in the quality of the air—we muſt acknowledge it to be very probable, that the intermediate ſtate of vapour is no other than air—and that the clouds do not proceed from any diſtinct fluid contained in the atmoſphere, but from a decompoſition of a part of the air itſelf, perfectly ſimilar to the reſt. Rain.

It appears, to us at leaſt, that M. de Luc's mode of reaſoning on this ſubject agrees better with the phenomena than Dr Hutton's. The Doctor, however, thinks differently, and publiſhed anſwers to the objections of M. de Luc with regard to his theory of rain; to which M. de Luc replied in a letter which was printed in the Appendix to the 81ſt volume of the Monthly Review: but it would extend our article beyond its due bounds, to give a view of this controverſy. See VAPOUR, WATER, WEATHER, and WIND.

As to the general quantity of rain that falls, and its proportion in ſeveral places at the ſame time, and in the ſame place at ſeveral times, we have many obſervations, journals, &c. in the Memoirs of the French Academy, the Philoſophical Tranſactions, &c. Upon meaſuring, then, the rain falling yearly, its depth, at a medium, and its proportion in ſeveral places, is found as in the following table:

	Inches.
At Townley, in Lancaſhire, obſerved by Mr Townley - - -	42 1/2
Upminſter, in Eſſex, by Dr Derham -	19 1/4
Zurich, in Swiſſerland, by Dr Scheuchzer	32 1/4
Piſa, in Italy, by Dr Mich. Ang. Tilli -	43 1/4
Paris, in France, by M. de la Hire -	19
Liſle, in Flanders, by M. de Vauban -	24

At Upminſter.			At Paris.	
1700	19 Inch.	.03	21 Inch.	.37
1701	18	.69	27	.77
1702	20	.38	17	.45
1703	23	.99	18	.51
1704	15	.80	21	.20
1705	16	.93	14	.82

From the Meteorological Journal of the Royal Society, kept by order of the preſident and council, it appears that the whole quantity of rain at London, in each of the years ſpecified below, was as follows, viz.

	Inches.	
1774 - -	26	.328
1775 - -	24	.083
1776 - -	20	.354
1777 - -	25	.371
1778 - -	20	.772
1779 - -	26	.785
1780 - -	17	.313

The quantity of rain in the four following years at London was,

	Inches.	
In 1789 - -	21	.976
1790 - -	16	.052
1791 - -	15	.310
1792 - -	19	.489

Rain.

Proportion of the Rain of the ſeveral Seaſons to one another.

1708	Depth at Piſa. Inch.	Depth at Upminſ. Inch.	Depth at Zurich. Inch.	1708	Depth at Piſa. Inch.	Depth at Upminſ. Inch.	Depth at Zurich. Inch.
Jan.	6 .41	2 .88	1 .64	July	0 .00	1 .11	3 .50
Feb.	3 .28	0 .46	1 .65	Aug.	2 .27	2 .94	3 .15
Mar.	2 .65	2 .03	1 .51	Sept.	7 .21	1 .46	3 .02
April	1 .25	0 .96	4 .69	Oct.	5 .33	0 .23	2 .44
May	3 .33	2 .02	1 .91	Nov.	0 .13	0 .86	0 .62
June	4 .90	2 .32	5 .91	Dec.	0 .00	1 .97	2 .62
Half Year	21 .82	10 .67	17 .31	Half Year	14 .94	8 .57	15 .35

See Philoſophical Tranſactions abridged, vol. iv. p. ii. p. 81, &c. and alſo Meteorological Journal of the Royal Society, publiſhed annually in the Philoſophical Tranſactions.

As to the uſe of rain, we may obſerve, that it moiſtens and ſoftens the earth, and thus fits it for affording nouriſhment to plants; by falling on high mountains, it carries down with it many particles of looſe earth, which ſerve to fertilize the ſurrounding valleys, and purifies the air from noxious exhalations, which tend in their return to the earth to meliorate the ſoil; it moderates the heat of the air; and is one means of ſupplying fountains and rivers. However, vehement rains in many countries are found to be attended with barrenneſs and poorneſs of the lands, and miſcarriage of the crops in the ſucceeding year: and the reaſon is plain; for theſe exceſſive ſtorms waſh away the fine mould into the rivers, which carry it into the ſea, and it is a long time before the land recovers itſelf again. The remedy to the famine, which ſome countries are ſubject to from this ſort of miſchief, is the planting large orchards and groves of ſuch trees as bear eſculent fruit; for it is an old obſervation, that in years, when grain ſucceeds worſt, theſe trees produce moſt fruit of all. It may partly be owing to the thorough moiſtening of the earth, as deep as their roots go by theſe rains, and partly to their trunks ſtopping part of the light mould carried down by the rains, and by this means furniſhing themſelves with a coat of new earth.

Preternatural RAINS. We have numerous accounts, in the hiſtorians of our own as well as other countries, of preternatural rains; ſuch as the raining of ſtones, of duſt, of blood, nay, and of living animals, as young frogs, and the like. We are not to doubt the truth of what thoſe who are authors of veracity and credit relate to us of this kind, ſo far as to ſuppoſe that the falling of ſtones and duſt never happened; the whole miſtake is, the ſuppoſing them to have fallen from the clouds: but as to the blood and frogs, it is very certain that they never fell at all, but the opinion has been a mere deception of the eyes. Men are extremely fond of the marvellous in their relations; but the judicious reader is to examine ſtrictly whatever is reported of this kind, and is not to ſuffer himſelf to be deceived.

There are two natural methods by which quantities of ſtones and duſt may fall in certain places, without their having been generated in the clouds or fallen as rain. The one is by means of hurricanes: the wind which we frequently ſee tearing off the tiles of houſes, and carrying them to conſiderable diſtances, being equally able to take up a quantity of ſtones, and drop them again at ſome other place. But the other, which is much the moſt powerful, and probably the moſt uſual way, is for the eruptions of volcanoes and burning mountains to toſs up, as they frequently do, a vaſt quantity of ſtones, aſhes, and cinders, to an immenſe height in the air: and theſe, being hurried away by the hurricanes and impetuous winds which uſually accompany thoſe eruptions, and being in themſelves much lighter than common ſtones, as being half calcined, may eaſily be thus carried to vaſt diſtances; and there falling in places where the inhabitants know nothing of the occaſion, they cannot but be ſuppoſed by the vulgar to fall on them from the clouds. It is well known, that, in the great eruptions of Ætna and Veſuvius, ſhowers of aſhes, duſt, and ſmall cinders, have been ſeen to obſcure the air, and overſpread the ſurface of the ſea for a great way, and cover the decks of ſhips; and this at ſuch a diſtance, as it ſhould appear ſcarce conceivable that they ſhould have been carried to: and probably, if the accounts of all the ſhowers of theſe ſubſtances mentioned by authors be collected, they will all be found to have fallen within ſuch diſtances of volcanoes; and if compared as to the time of their falling, will be found to correſpond in that alſo with the eruptions of thoſe mountains. We have known inſtances of the aſhes from Veſuvius having been carried thirty, nay, forty leagues, and peculiar accidents may have carried them yet farther. It is not to be ſuppoſed that theſe ſhowers of ſtones and duſt fall for a continuance in the manner of ſhowers of rain, or that the fragments or pieces are as frequent as drops of water; it is ſufficient that a number of ſtones, or a quantity of duſt, fall at once on a place, where the inhabitants can have no knowledge of the part from whence they came, and the vulgar will not doubt their dropping from the clouds. Nay, in the canton of Berne in Swiſſerland, the inhabitants accounted it a miracle that it rained earth and ſulphur upon them at a time that a ſmall volcano terrified them; and even while the wind was ſo boiſterous, and hurricanes ſo frequent, that they ſaw almoſt every moment the duſt, ſand, and little ſtones torn up from the ſurface of the earth in whirlwinds, and carried to a conſiderable height in the air, they never conſidered that both the ſulphur thrown up by the volcano, and the duſt, &c. carried from their feet muſt fall ſoon after ſomewhere. It is very certain that in ſome of the terrible ſtorms of large hail, where the hail-ſtones have been of many inches round, on breaking them there have been found what people have called *ſtones in their middle;* but theſe obſervers needed only to have waited the diſſolving of one of theſe hail-ſtones, to have ſeen the ſtone in its centre diſunite alſo, it being only formed of the particles of looſe earthy matter, which the water, exhaled by the ſun's heat, had taken up in extremely ſmall moleculæ with it; and this only having ſerved to give an opake hue to the inner part of the congelation, to which the freezing of the water alone gave the apparent hardneſs of ſtone.

The raining of *blood* has been ever accounted a more terrible ſight and a more fatal omen than the other preternatural rains already mentioned. It is very certain that nature forms blood nowhere but in the veſſels of animals; and therefore ſhowers of it from the clouds are by no means to be credited. Thoſe who ſuppoſe that what has been taken for blood has been actually ſeen falling through the air, have had recourſe to flying inſects for its origin, and ſuppoſe it the eggs or dung of

Rain. certain butterflies discharged from them as they were high up in the air. But it seems a very wild conjecture, as we know of no butterfly whose excrements or eggs are of such a colour, or whose abode is so high, or their flocks so numerous, as to be the occasion of this.

It is most probable that these bloody waters were never seen falling; but that people seeing the standing waters blood-coloured, were assured, from their not knowing how it should else happen, that it had rained blood into them. A very memorable instance of this there was at the Hague in the year 1670. Swammerdam, who relates it, tells us, that one morning the whole town was in an uproar on finding their lakes and ditches full of blood, as they thought; and having been certainly full of water the night before, they agreed it must have rained blood in the night: but a certain physician went down to one of the canals, and taking home a quantity of this blood-coloured water, he examined it by the microscope, and found that the water was water still, and had not at all changed its colour; but that it was full of prodigious swarms of small red animals, all alive, and very nimble in their motions, whose colour and prodigious number gave a red tinge to the whole body of the water they lived in, on a less accurate inspection. The certainty that this was the case, did not however persuade the Hollanders to part with the miracle: they prudently concluded, that the sudden appearance of such a number of animals was as great a prodigy as the raining of blood would have been; and are assured to this day, that this portent foretold the scene of war and destruction which Louis XIV. afterwards brought into that country, which had before enjoyed 40 years uninterrupted peace.

The animals which thus colour the water of lakes and ponds are the *pulices arborescentes* of Swammerdam, or the water-fleas with branched horns. These creatures are of a reddish-yellow or flame colour: they live about the sides of ditches, under weeds, and among the mud; and are therefore the less visible, except at a certain time, which is in the end or beginning of June: it is at this time that these little animals leave their recesses to float loose about the water, to meet for the propagation of their species, and by that means become visible in the colour they give the water. This is visible, more or less, in one part or other of almost all standing waters at this season; and it is always at this season that the bloody waters have alarmed the ignorant. See *Pulex Monoculus*.

The raining of *frogs* is a thing not less wonderful in the accounts of authors who love the marvellous, than those of blood or stones; and this is supposed to happen so often, that there are multitudes who pretend to have been eye-witnesses of it. These rains of frogs always happen after very dry seasons, and are much more frequent in the hotter countries than in the cold ones. In Italy they are very frequent; and it is not uncommon to see the streets of Rome swarming both with young frogs and toads in an instant in a shower of rain; they hopping everywhere between the people's legs as they walk, though there was not the least appearance of them before. Nay, they have been seen to fall through the air down upon the pavements. This seems a strong circumstance in favour of their being rained down from the clouds; but, when strictly examined, it comes to nothing: for these frogs that are seen to fall, are always found dead, lamed, or bruised by the fall, and never hop about as the rest; and they are never seen to fall, except close under the walls of houses, from the roofs and gutter of which they have accidentally slipped down. Some people, who love to add to strange things yet stranger, affirm that they have had the young frogs fall into their hats in the midst of an open field; but this is idle, and wholly false. Rain.

Others, who cannot agree to their falling from the clouds, have tried to solve the difficulty of their sudden appearance, by supposing them hatched out of the egg, or spawn, by these rains. Nay, some have supposed them made immediately out of the dust: but there are unanswerable arguments against all these suppositions. Equivocal generation, or the spontaneous production of animals out of dust, is now wholly exploded. The fall from the clouds must destroy and kill these tender and soft-bodied animals: and they cannot be at this time hatched immediately out of eggs; because the young frog does not make its appearance from the egg in form, but has its hinder legs enveloped in a skin, and is what we call a *tadpole*; and the young frogs are at least 100 times larger at the time of their appearance, than the egg from which they should be hatched.

It is beyond a doubt, that the frogs which make their appearance at this time, were hatched and in being long before: but that the dry seasons had injured them, and kept them sluggishly in holes or coverts; and that all the rain does, is the enlivening them, giving them new spirits, and calling them forth to seek new habitations, and enjoy the element they were destined in great part to live in. Theophrastus, the greatest of all the naturalists of antiquity, has affirmed the same thing. We find that the error of supposing these creatures to fall from the clouds was as early as that author's time; and also that the truth, in regard to their appearance, was as early known; though, in the ages since, authors have taken care to conceal the truth, and to hand down to us the error. We find this venerable sage, in a fragment of his on the generation of animals which appear on a sudden, bantering the opinion, and asserting that they were hatched and living long before. The world owes, however, to the accurate Signior Redi the great proof of this truth, which Theophrastus only has affirmed: for this gentleman, dissecting some of these new-appearing frogs, found in their stomachs herbs and other half-digested food; and, openly showing this to his credulous countrymen, asked them whether they thought that nature, which engendered, according to their opinion, these animals in the clouds, had also been so provident as to engender grass there for their food and nourishment?

To the raining of frogs we ought to add the raining of *grasshoppers* and *locusts*, which have sometimes appeared in prodigious numbers, and devoured the fruits of the earth. There has not been the least pretence for the supposing that these animals descended from the clouds, but that they appeared on a sudden in prodigious numbers. The naturalist, who knows the many accidents attending the eggs of these and other the like animals, cannot but know that some seasons will prove particularly favourable to the hatching them, and the prodigious number of eggs that many insects lay could not but every year bring us such abundance of the young, were they not liable to many accidents, and had not provident nature taken care, as in many plants, to continue the

Rain. the ſpecies by a very numerous ſtock of ſeeds, of which perhaps not one in 500 need take root in order to continue an equal number of plants. As it is thus alſo in regard to inſects, it cannot but happen, that if a favourable ſeaſon encourage the hatching of all thoſe eggs, a very ſmall number of which alone were neceſſary to continue the ſpecies, we muſt, in ſuch ſeaſons, have a proportionate abundance of them. There appeared about 50 years ago, in London, ſuch a prodigious ſwarm of the little beetle we call the *lady-cow*, that the very poſts in the ſtreets were everywhere covered with them. But thanks to the progreſs of philoſophy among us, we had no body to aſſert that it rained cow-ladies, but contented ourſelves with ſaying that it had been a favourable ſeaſon for their eggs. The prodigious number of a ſort of grub which did vaſt miſchief about the ſame period among the corn and graſs by eating off their roots, might alſo have been ſuppoſed to proceed from its having rained grubs by people fond of making every thing a prodigy; but our knowledge in natural hiſtory aſſured us, that theſe were only the hexapode worms of the common hedge-beetle called the *cock-chafer*.

The raining of *fiſhes* has been a prodigy alſo much talked of in France, where the ſtreets of a town at ſome diſtance from Paris, after a terrible hurricane in the night, which tore up trees, blew down houſes, &c. were found in a manner covered with fiſhes of various ſizes. Nobody here made any doubt of theſe having fallen from the clouds; nor did the abſurdity of fiſh, of five or ſix inches long, being generated in the air, at all ſtartle the people, or ſhake their belief in the miracle, till they found, upon inquiry, that a very well-ſtocked fiſh-pond, which ſtood on an eminence in the neighbourhood, had been blown dry by the hurricane, and only the great fiſh left at the bottom of it, all the ſmaller fry having been toſſed into their ſtreets.

Upon the whole, all the ſuppoſed marvellous rains have been owing to ſubſtances naturally produced on the earth, and either never having been in the air at all, or only carried thither by accident.

In Sileſia, after a great dearth of wheat in that country, there happened a violent ſtorm of wind and rain, and the earth was afterwards covered, in many places, with ſmall round ſeeds. The vulgar cried out that Providence had ſent them food, and that it had rained *millet*: but theſe were, in reality, only the ſeeds of a ſpecies of veronica, or ſpeed-well, very common in that country; and whoſe ſeeds being juſt ripe at that time, the wind had diſlodged them from their capſules, and ſcattered them about. In our own country, we have hiſtories of rains of this marvellous kind, but all fabulous. It was once ſaid to rain *wheat* in Wiltſhire; and the people were all alarmed at it as a miracle, till Mr Cole ſhowed them, that what they took for wheat was only the ſeeds or kernels of the berries of ivy, which being then fully ripe, the wind had diſlodged from the ſides of houſes, and trunks of trees, on which the ivy that produced them crept.

And we even once had a raining of fiſhes near the coaſt of Kent in a terrible hurricane, with thunder and lightning. The people who ſaw ſmall ſprats ſtrewed all about afterwards, would have it that they had fallen from the clouds; but thoſe who conſidered how far the high winds have been known to carry the ſea-water, did not wonder that they ſhould be able to carry ſmall fiſh with it ſo ſmall a part of the way. Rain.

In the Philoſophical Tranſactions for 1782 we have the following account of a preternatural kind of rain by Count de Gioeni: "The morning of the 24th inſtant there appeared here a moſt ſingular phenomenon. Every place expoſed to the air was found wet with a coloured cretaceous grey water, which, after evaporating and filtrating away, left every place covered with it to the height of two or three lines; and all the iron-work that was touched by it became ruſty.

"The public, inclined to the marvellous, fancied various cauſes of this rain, and began to fear for the animals and vegetables.

"In places where rain-water was uſed, they abſtained from it: ſome ſuſpecting vitriolic principles to be mixed with it, and others predicting ſome epidemical diſorder.

"Thoſe who had obſerved the exploſions of Etna 20 days and more before, were inclined to believe it originated from one of them.

"The ſhower extended from N. $\frac{1}{4}$ N.E. to S. $\frac{1}{4}$ S.W. over the fields, about 70 miles in a right line from the vertex of Etna.

"There is nothing new in volcanos having thrown up ſand, and alſo ſtones, by the violent expanſive force generated within them, which ſand has been carried by the wind to diſtant regions.

"But the colour and ſubtilty of the matter occaſioned doubts concerning its origin; which increaſed from the remarkable circumſtance of the water in which it came incorporated; for which reaſons ſome other principle or origin was ſuſpected.

"It became, therefore, neceſſary by all means to aſcertain the nature of this matter, in order to be convinced of its origin, and of the effects it might produce. This could not be done without the help of a chemical analyſis. To do this then with certainty, I endeavoured to collect this rain from places where it was moſt probable no heterogeneous matter would be mixed with it. I therefore choſe the plant called *braſſica capitata*, which having large and turned-up leaves, they contained enough of this coloured water: many of theſe I emptied into a veſſel, and left the contents to ſettle till the water became clear.

"This being ſeparated into another veſſel, I tried it with vegetable alkaline liquors and mineral acids; but could obſerve no decompoſition by either. I then evaporated the water in order to reunite the ſubſtances that might be in ſolution; and touching it again with the aforeſaid liquors, it ſhowed a ſlight effervеſcence with the acids. When tried with the ſyrup of violets, this became a pale green; ſo that I was perſuaded it contained a calcareous ſalt. With the decoction of galls no precipitation was produced.

"The matter being afterwards dried in the ſhade, it appeared a very ſubtile fine earth, of a cretaceous colour, but inert, from having been diluted by the rain.

"I next thought of calcining it with a ſlow fire, and it aſſumed the colour of a brick. A portion of this being put into a crucible, I applied to it a ſtronger heat; by which it loſt almoſt all its acquired colour. Again, I expoſed a portion of this for a longer time to a very violent heat (from which a vitrification might be expected);

Rain, Rainbow.

expected); it remained, however, quite ſoft, and was eaſily bruiſed, but returned to its original duſky colour.

"From the moſt accurate obſervations of the ſmoke from the three calcinations, I could not diſcover either colour or ſmell that indicated any arſenical or ſulphureous mixture.

"Having therefore calcined this matter in three portions, with three different degrees of fire, I preſented a good magnet to each: it did not act either on the firſt or ſecond; a ſlight attraction was viſible in many places on the third: this perſuaded me, that this earth contains a martial principle in a metallic form, and not in a vitriolic ſubſtance.

"The nature of theſe ſubſtances then being diſcovered, their volcanic origin appears; for iron, the more it is expoſed to violent calcination, the more it is divided by the loſs of its phlogiſtic principle; which cannot naturally happen but in the great chimney of a volcano. Calcareous ſalt, being a marine ſalt combined with a calcareous ſubſtance by means of violent heat, cannot be otherwiſe compoſed than in a volcano.

"As to their dreaded effects on animals and vegetables, every one knows the advantageous uſe, in medicine, both of the one and the other, and this in the ſame form as they are thus prepared in the great laboratory of nature.

"Vegetables, even in flower, do not appear in the leaſt macerated, which has formerly happened from only ſhowers of ſand.

"How this volcanic production came to be mixed with water may be conceived in various ways.

"Ætna, about its middle regions, is generally ſurrounded with clouds that do not always riſe above its ſummit, which is 2900 paces above the level of the ſea. This matter being thrown out, and deſcending upon the clouds below it, may happen to mix and fall in rain with them in the uſual way. It may alſo be conjectured, that the thick ſmoke which the volcanic matter contained might, by its rarefaction, be carried in the atmoſphere by the winds over that tract of country; and then cooling ſo as to condenſe and become ſpecifically heavier than the air, might deſcend in that coloured rain.

"I muſt, however, leave to philoſophers (to whom the knowledge of natural agents belongs) the examination and explanation of ſuch phenomena, confining myſelf to obſervation and chemical experiments."

RAIN, a well built and fortified town of Bavaria, one of the keys of this electorate, on the Lech, 20 miles weſt of Ingolſtadt. N. Lat. 48. 51. E. Long. 11. 12.

RAIN-Bird. See CUCULUS, nº 8.

RAINBOW. See OPTICS, Part II. Sect. i. § 1.

In the Philoſophical Tranſactions for 1793, we have the following account of two rainbows ſeen by the Rev. Mr Sturges.

"On the evening of the 9th of July 1792, between ſeven and eight o'clock, at Alverſtoke, near Goſport, on the ſea-coaſt of Hampſhire, there came up, in the ſouth-eaſt, a cloud with a thunder-ſhower; while the ſun ſhone bright, low in the horizon to the north-weſt.

Plate CCCCXXVII. fig. 2.

"In this ſhower two primary rainbows appeared, AB and AC, not concentric, but touching each other at A, in the ſouth part of the horizon; with a ſecondary bow to each, DE and DF (the laſt very faint, but diſcernible), which touched likewiſe at D. Both the primary were very vivid for a conſiderable time, and at different times nearly equally ſo; but the bow AB was moſt permanent, was a larger ſegment of a circle, and at laſt, after the other had vaniſhed, became almoſt a ſemicircle; the ſun being near ſetting. It was a perfect calm, and the ſea was as ſmooth as glaſs.

Rainbow.

"If I might venture to offer a ſolution of this appearance, it would be as follows. I conſider the bow AB as the true one, produced by the ſun itſelf; and the other, AC, as produced by the reflection of the ſun from the ſea, which, in its perfectly ſmooth ſtate, acted as a ſpeculum. The direction of the ſea, between the Iſle of Wight and the land, was to the north-weſt in a line with the ſun, as it was then ſituated. The image reflected from the water, having its rays iſſuing from a point lower than the real ſun, and in a line coming from beneath the horizon, would conſequently form a bow higher than the true one AB. And the ſhores, by which that narrow part of the ſea is bounded, would before the ſun's actual ſetting intercept its rays from the ſurface of the water, and cauſe the bow AC, which I ſuppoſe to be produced by the reflection, to diſappear before the other."

The marine or ſea bow is a phenomenon which may be frequently obſerved in a much agitated ſea, and is occaſioned by the wind ſweeping part of the waves, and carrying them aloft; which when they fall down are refracted by the ſun's rays, which paint the colours of the bow juſt as in a common ſhower. Theſe bows are often ſeen when a veſſel is ſailing with conſiderable force, and daſhing the waves around her, which are raiſed partly by the action of the ſhip and partly by the force of the wind, and, falling down, they form a rainbow; and they are alſo often occaſioned by the daſhing of the waves againſt the rocks on ſhore.

In the Philoſophical Tranſactions, it is obſerved by F. Bourzes, that the colours of the marine rainbow are leſs lively, leſs diſtinct, and of ſhorter continuance, than thoſe of the common bow; that there are ſcarce above two colours diſtinguiſhable, a dark yellow on the ſide next the ſun, and a pale green on the oppoſite ſide. But they are more numerous, there being ſometimes 20 or 30 ſeen together.

To this claſs of bows may be referred a kind of white or colourleſs rainbows, which Mentzelius and others affirm to have ſeen at noon-day. M. Marlotte, in his fourth *Eſſai de Phyſique*, ſays, theſe bows are formed in miſts, as the others are in ſhowers; and adds, that he has ſeen ſeveral both after ſun-riſing and in the night. The want of colours he attributes to the ſmallneſs of the vapours which compoſe the miſt; but perhaps it is rather from the exceeding tenuity of the little veſiculæ of the vapour, which being only little watery pellicles bloated with air, the rays of light undergo but little refraction in paſſing out of air into them; too little to ſeparate the differently coloured rays, &c. Hence the rays are reflected from them, compounded as they came, that is, white. Rohault mentions * coloured rainbows on the graſs; formed by the refractions of the ſun's rays in the morning dew. Rainbows have been alſo produced by the reflection of the ſun from a river; and in the Philoſophical Tranſactions, Vol. L. p. 294. we

* *Trait. de Phyſique.*

Rainbow. have an account of a rainbow, which muſt have been formed by the exhalations from the city of London, when the ſun had been ſet 20 minutes, and conſequently the centre of the bow was above the horizon. The colours were the ſame as in the common rainbow, but fainter.

It has often been made a ſubject of inquiry among the curious how there came to be no rainbow before the flood, which is thought by ſome to have been the caſe from its being made a ſign of the covenant which the Deity was pleaſed to make with man after that event. Mr Whitehurſt, in his *Inquiry into the Original State and Formation of the Earth*, p. 173, &c. endeavours to eſtabliſh it as a matter of great probability at leaſt, that the antediluvian atmoſphere was ſo uniformly temperate as never to be ſubject to ſtorms, tempeſts, or rain, and of courſe it could never exhibit a rainbow. For our own part, we cannot ſee how the earth at that period could do without rain any more than at preſent; and it appears to us from Scripture equally probable that the rainbow was ſeen before the flood as after it. It was then, however, made a token of a certain covenant; and it would unqueſtionably do equally well for that purpoſe if it had exiſted before as if it had not.

Lunar RAINBOW. The moon ſometimes alſo exhibits the phenomenon of an iris or rainbow by the refraction of her rays in drops of rain in the night-time. This phenomenon is very rare. In the Philoſophical Tranſactions for 1783, however, we have an account of three ſeen in one year, and all in the ſame place, communicated in two letters by Marmaduke Tunſtall, Eſq. The firſt was ſeen 27th February 1782, at Greta Bridge, Yorkſhire, between ſeven and eight at night, and appeared "in tolerably diſtinct colours, ſimilar to a ſolar one, but more faint: the orange colour ſeemed to predominate. It happened at full moon; at which time alone they are ſaid to have been always ſeen. Though Ariſtotle is ſaid to have obſerved two, and ſome others have been ſeen by Suellius, &c. I can only find two deſcribed with any accuracy; viz. one by Plot, in his Hiſtory of Oxfordſhire, ſeen by him in 1675, though without colours; the other ſeen by a Derbyſhire gentleman at Glapwell, near Cheſterfield, deſcribed by Thoreſby, and inſerted in N° 331. of the Philoſophical Tranſactions: this was about Chriſtmas, 1710, and ſaid to have had all the colours of the Iris Solaris. The night was windy; and though there was then a drizzling rain and dark cloud, in which the rainbow was reflected, it proved afterwards a light froſt."

Two others were afterwards ſeen by Mr Tunſtall; one on July the 30th, about 11 o'clock, which laſted about a quarter of an hour, without colours. The other, which appeared on Friday October 18. was "perhaps the moſt extraordinary one of the kind ever ſeen. It was firſt viſible about nine o'clock, and continued, tho' with very different degrees of brilliancy, till paſt two. At firſt, though a ſtrongly marked bow, it was without colours; but afterwards they were very conſpicuous and vivid in the ſame form as in the ſolar, though fainter; the red, green, and purple, were moſt diſtinguiſhable. About twelve it was the moſt ſplendid in appearance; its arc was conſiderably a ſmaller ſegment of a circle than a ſolar; its ſouth-eaſt limb firſt began to fail, and a conſiderable time before its final extinction: the wind was very high, nearly due weſt, moſt part of the time, accompanied with a drizzling rain. It is a ſingular circumſtance, that three of theſe phenomena ſhould have been ſeen in ſo ſhort a time in one place, as they have been eſteemed ever ſince the time of Ariſtotle, who is ſaid to have been the firſt obſerver of them, and ſaw only two in 50 years, and ſince by Plot and Thoreſby, almoſt the only two Engliſh authors who have ſpoke of them, to be exceeding rare. They ſeem evidently to be occaſioned by a refraction in a cloud or turbid atmoſphere, and in general are indications of ſtormy and rainy weather: ſo bad a ſeaſon as the late ſummer having, I believe, ſeldom occurred in England. Thoreſby, indeed, ſays, the one he obſerved was ſucceeded by ſeveral days of fine ſerene weather. One particular, rather ſingular, in the ſecond, viz. of July the 30th, was its being ſix days after the full of the moon; and the laſt, though of ſo long a duration, was three days before the full: that of the 27th of February was exactly at the full, which uſed to be judged the only time they could be ſeen, though in the Encyclopedia there is an account that Weidler obſerved one in 1719, in the firſt quarter of the moon, with faint colours, and in very calm weather. No lunar iris, I ever heard or read of, laſted near ſo long as that on the 18th inſtant, either with or without colours." Rainbow, Raiſins.

In the Gentleman's Magazine for Auguſt 1788 we have an account of a lunar rainbow by a correſpondent who ſaw it. "On Sunday evening the 17th of Auguſt (ſays he), after two days, on both of which, particularly the former, there had been a great deal of rain, together with lightning and thunder, juſt as the clocks were ſtriking nine, 23 hours after full moon, looking through my window, I was ſtruck with the appearance of ſomething in the ſky, which ſeemed like a rainbow. Having never ſeen a rainbow by night, I thought it a very extraordinary phenomenon, and haſtened to a place where there were no buildings to obſtruct my view of the hemiſphere: here I found that the phenomenon was no other than a lunar rainbow; the moon was truly 'walking in brightneſs,' brilliant as ſhe could be; not a cloud was to be ſeen near her; and over-againſt her, toward the north-weſt, or perhaps rather more to the north, was a rainbow, a vaſt arch, perfect in all its parts, not interrupted or broken as rainbows frequently are, but unremittedly viſible from one horizon to the other. In order to give ſome idea of its extent, it is neceſſary to ſay, that as I ſtood toward the weſtern extremity of the pariſh of Stoke Newington, it ſeemed to take its riſe from the weſt of Hampſtead, and to the end, perhaps, in the river Lea, the eaſtern boundary of Tottenham; its colour was white, cloudy, or greyiſh, but a part of its weſtern leg ſeemed to exhibit tints of a faint ſickly green. I continued viewing it for ſome time, till it began to rain; and at length the rain increaſing, and the ſky growing more hazy, I returned home about a quarter or 20 minutes paſt nine, and in ten minutes came out again; but by that time all was over, the moon was darkened by clouds, and the rainbow of courſe vaniſhed."

Marine RAINBOW, or *Sea-bow*. See the article RAINBOW.

Rainbow-Stone. See *Moon-Stone*.

RAISINS, grapes prepared by ſuffering them to remain on the vine till they are perfectly ripe, and then drying them in the ſun, or by the heat of an oven.

Raiſin || Raleigh.

The difference between raiſins dried in the ſun and thoſe dried in ovens, is very obvious: the former are ſweat and pleaſant, but the latter have a latent acidity with the ſweetneſs that renders them much leſs agreeable.

The common way of drying grapes for raiſins, is to tie two or three bunches of them together while yet on the vine, and dip them into a hot lixivium of wood-aſhes, with a little of the oil of olives in it. This diſpoſes them to ſhrink and wrinkle; and after this they are left on the vine three or four days ſeparated on ſticks in an horizontal ſituation, and then dried in the ſun at leiſure, after being cut from the tree. The fineſt and beſt raiſins are thoſe called in ſome places *Damaſcus* and *Jube raiſins*; which are diſtinguiſhed from the others by their ſize and figure: they are flat and wrinkled on the ſurface, ſoft and juicy within, and near an inch long; and, when freſh and growing on the bunch, are of the ſize and ſhape of a large olive.

The raiſins of the ſun, and jar-raiſins, are all dried by the heat of the ſun; and theſe are the ſorts uſed in medicine. However, all the kinds have much the ſame virtues: they are all nutritive and balſamic; they are allowed to be attenuant, are ſaid to be good in nephritic complaints, and are an ingredient in pectoral decoctions: in which caſes, as alſo in all others where aſtringency is not required of them, they ſhould have the ſtones carefully taken out.

Raisin-Wine. See Wine.

RAKKATH (anc. geog.), a town of Upper Galilee, thought to be Tiberias, (Talmud): but this is denied by Reland, who ſays that Rakkath was a town of the tribe of Naphthali.

RAKE is a well known inſtrument with teeth, by which the ground is divided. See Agriculture, p. 318.

Rake alſo means a looſe, diſorderly, vicious, and thoughtleſs fellow.

Rake of a Ship, is all that part of her hull which hangs over both ends of her keel. That which is before is called the *fore rake*, or *rake forward*, and that part which is at the ſetting on of the ſtern-poſt is called the *rake-aft*, or *afterward*.

RALEIGH (Sir Walter), fourth ſon of Walter Raleigh, Eſq; of Fardel, in the pariſh of Cornwood in Devonſhire, was born in 1552 at Hayes, in the pariſh of Budley, a farm belonging to his father. About the year 1568, he was ſent to Oriel college in Oxford, where he continued but a ſhort time; for in the following year he embarked for France, being one of the hundred volunteers, commanded by Henry Champernon, who, with other Engliſh troops, were ſent by queen Eliſabeth to aſſiſt the queen of Navarre in defending the Proteſtants. In this ſervice he continued for five or ſix years; after which he returned to London, and probably reſided in the Middle Temple. But his enterpriſing genius would not ſuffer him to remain long in a ſtate of inactivity. In 1577 or 1578, he embarked for the Low Countries with the troops ſent by the queen to aſſiſt the Dutch againſt the Spaniards, and probably ſhared the glory of the deciſive victory over Don John of Auſtria in 1578. On his return to England, a new enterpriſe engaged his attention. His half-brother, Sir Humphrey Gilbert, having obtained a patent to plant and inhabit ſome parts of North America, Mr Raleigh embarked in this adventure; but, meeting with a Spaniſh fleet, after a ſmart engagement they returned, without ſucceſs, in 1579. Raleigh.

The following year, the king of Spain, in conjunction with the pope, having projected a total conqueſt of the Engliſh dominions, ſent troops to Ireland to aſſiſt the Deſmonds in the Munſter rebellion. Raleigh obtained a captain's commiſſion under Lord Grey of Wilton, then deputy of Ireland, and embarked for that kingdom; where, by his conduct and reſolution, he was principally inſtrumental in putting an end to the rebellious attempt. He returned to England; and attracted the notice of queen Eliſabeth, owing, as we are told in Naunton's *Fragmenta Regalia*, to the following accidental piece of gallantry. The queen, as ſhe was one day taking a walk, being ſtopped by a *ſplaſhy* place in the road, our gallant young ſoldier took off his new pluſh mantle, and ſpread it on the ground. Her majeſty trod gently over the fair foot-cloth, ſurpriſed and pleaſed with the adventure. He was a handſome man, and remarkable for his gentility of addreſs.

The queen admitted him to her court, and employed him firſt as an attendant on the French ambaſſador Simier on his return home, and afterward to eſcort the duke of Anjou to Antwerp. During this excurſion he became perſonally known to the prince of Orange; from whom, at his return, he brought ſpecial acknowledgments to the queen, who now frequently converſed with him. But the inactive life of a courtier did not ſuit the enterpriſing ſpirit of Mr Raleigh. In the year 1583, he embarked with his brother, Sir Humphrey Gilbert, on a ſecond expedition to Newfoundland, in a ſhip called the *Raleigh*, which he built at his own expence; but was obliged to return on account of an infectious diſtemper on board. He was, however, ſo little affected by this diſappointment, that he now laid before the queen and council a propoſal for exploring the continent of North America; and in 1584 obtained a patent empowering him to poſſeſs ſuch countries as he ſhould diſcover in that part of the globe. Accordingly Mr Raleigh fitted out two ſhips at his own expence, which ſailed in the month of April, and returned to England about the middle of September, reporting that they had diſcovered and taken poſſeſſion of a fine country called *Windangocoa*, to which the queen gave the name of *Virginia*. About this time he was elected knight of the ſhire for the county of Devon, and ſoon after received the honour of knighthood; and to enable him to carry on his deſigns abroad, the queen granted him a patent for licenſing the venders of wine throughout the kingdom. In 1585 he ſent a fleet of ſeven ſhips to Virginia, commanded by his relation Sir Richard Greenville, who left a colony at Roanah of 107 perſons, under the government of Mr Lane; and by the eſtabliſhment of this colony he firſt imported tobacco into England. See Nicotiana. In the ſame year Sir Walter Raleigh obtained a grant of 12,000 acres of the forfeited lands in the county of Corke in Ireland.—About the ſame time he was made ſeneſchal of the duchy of Cornwall, and warden of the ſtanneries; and grew into ſuch favour with the queen, that even Leiceſter was jealous of his influence.

In 1587, he ſent another colony of 150 men to Virginia, with a governor, Mr John White, and 12 aſſiſtants. About this time we find our knight diſtinguiſh-

Raleigh

ed by the titles of *Captain of the queen's guards*, and *Lieutenant general of Cornwall*. From this period to the year 1594, he was continually engaged in projecting new expeditions, ſending ſuccours to colonies abroad, defending the kingdom from the inſults of the Spaniards, and tranſacting parliamentary buſineſs, with equal ability and reſolution. Whilſt thus employed, he was publicly charged, in a libel written by the infamous Jeſuit Parſons, with being an Atheiſt; a groundleſs and ridiculous imputation. In 1594, he obtained from the queen a grant of the manor of Sherborne in Dorſetſhire, where he built a magnificent houſe: but Sir Walter fell under the queen's diſpleaſure on account of an intrigue with the daughter of Sir Nicholas Throgmorton, one of the maids of honour; however, he married the lady, and lived with her in great conjugal harmony. During his diſgrace at court, he projected the conqueſt of Guiana in South America, and in 1595 ſailed for that country; of which having taken poſſeſſion, after defeating the Spaniards who were ſettled there, he returned to England the ſame year, and ſoon after publiſhed an account of his expedition. In the following year he was one of the admirals in the ſucceſsful expedition againſt Cadiz, under the command of Howard and the earl of Eſſex; and in 1597 he ſailed with the ſame commanders againſt the Azores. Soon after theſe expeditions, we find him aſſiduouſly engaged in parliamentary buſineſs, and a diſtinguiſhed perſonage in jouſts and tournaments. In 1600 he was ſent on a joint embaſſy with Lord Cobham to Flanders, and at his return made governor of Jerſey.

Queen Eliſabeth died in the beginning of the year 1603; and with her Raleigh's glory and felicity ſunk, never to riſe again. Upon the acceſſion of James, Sir Walter loſt his intereſt at court, was ſtripped of his preferments, and accuſed of a plot againſt the king. He was arraigned at Wincheſter, and, on his trial, inſulted by the moſt ſhocking brutality by the famous Coke, attorney-general, whoſe ſophiſtical vociferation influenced the jury to convict him without the leaſt proof of guilt. After a month's impriſonment, however, in daily expectation of his execution, he was reprieved, and ſent to the Tower; and his eſtates were given to Car, earl of Somerſet, the king's favourite. During this confinement, he wrote many of his moſt valuable pieces, particularly his Hiſtory of the World. In March 1615, after 16 years impriſonment, he obtained his liberty, and immediately began to prepare for another voyage to Guiana. In Auguſt 1616, the king granted him a very ample commiſſion for that purpoſe; and in July the year following, he ſailed from Plymouth: but, ſtrange as it may appear, it is moſt certain that the whole ſcheme was revealed to the Spaniards by the king himſelf, and thus neceſſarily rendered abortive.

He returned to England in 1618, where he was ſoon after ſeized, impriſoned, and beheaded; not for any pretended miſdemeanor on the late expedition, but in conſequence of his former attainder. The truth of the matter is, he was ſacrificed by the puſillanimous monarch to appeaſe the Spaniards; who, whilſt Raleigh lived, thought every part of their dominions in danger. He was executed in Old Palace Yard, and buried in St Margaret's adjoining, in the 66th year of his age. His behaviour on the ſcaffold was manly, unaffected, cheerful, and eaſy. Being aſked by the executioner which way he would lay his head, he anſwered, "So the heart be right, it is no matter which way the head lies." He was a man of admirable parts, extenſive knowledge, undaunted reſolution, and ſtrict honour and honeſty. He was the author of a great many works, ſome of which have not been printed.

Rallus.

RALLUS, the RAIL, in ornithology; a genus belonging to the order of grallæ. The beak is thickeſt at the baſe, compreſſed, equal, acute, and ſomewhat ſharp on the back near the point; the noſtrils are oval; the feet have four toes, without any web; and the body is compreſſed. Mr Latham, in his *Index Ornithologicus*, enumerates 24 ſpecies, beſides ſome varieties. They are chiefly diſtinguiſhed by their colour. "Theſe birds (ſays Buffon) conſtitute a large family, and their habits are different from thoſe of the other ſhore-birds, which reſide on ſands and gravel. The rails, on the contrary, inhabit only the ſlimy margins of pools and rivers, eſpecially low grounds covered with flags and other large marſh plants. This mode of living is habitual and common to all the ſpecies of water-rails. The land rail frequents meadows, and from the diſagreeable cry, or rather rattling in the throat of this bird, is derived the generic name. In all the rails, the body is ſlender, and ſhrunk at the ſides; the tail extremely ſhort; the head ſmall; the bill pretty like that of the gallinaceous kind, though much longer, and not ſo thick; a portion of the leg above the knee is bare; the three fore-toes without membranes, and very long: they do not, like other birds, draw their feet under their belly in flying, but allow them to hang down: their wings are ſmall and very concave, and their flight is ſhort.—They ſeem to be more diffuſed than varied; and nature has produced or tranſported them over the moſt diſtant lands. Captain Cook found them at the Straits of Magellan; in different iſlands of the ſouthern hemiſphere, at Anamoka, at Tanna, and at the iſle of Norfolk. In the Society Iſlands there are two ſpecies of rails; a little black ſpotted one, (*pooa-née*), and a little red-eyed one (*mai-ho*). It appears that the two acolins of Fernandez, which he denominates *water-quails*, are of a ſpecies of rails peculiar to the great lake of Mexico.—The colins, which might be confounded with theſe, are a kind of partridges." The principal are,

1. The aquaticus, or water-rail, is a bird of a long ſlender body, with ſhort concave wings. It delights leſs in flying than running: which it does very ſwiftly along the edges of brooks covered with buſhes: as it runs, it every now and then flirts up its tail, and in flying hangs down its legs; actions it has in common with the water-hen. Its weight is four ounces and a half. The length to the end of the tail is 12 inches; the breadth 16. The bill is ſlender, ſlightly incurvated, one inch three quarters long: the upper mandible black, edged with red; the lower, orange-coloured: the head, hind part of the neck, the back, and coverts of the wings and tail, are black, edged with an olive brown; the throat, breaſt, and upper part of the belly, are aſh-coloured: the ſides under the wings as far as the rump, finely varied with black and white bars. The tail is very ſhort, conſiſts of 12 black feathers; the ends of the two middle tipt with ruſt colour; the feathers immediately beneath the tail white. The legs are placed far behind, and are of a duſky fleſh-colour. The toes very long, and divided to their very origin; though the feet are not webbed, it takes the water; will ſwim on it with much eaſe, but is often obſerved to

Rallus. to run along the surface. "Water rails (ſays Buffon) are ſeen near the perennial fountains during the greateſt part of the winter, yet like the land rails they have their regular migrations. They paſs Malta in the ſpring and autumn. The Viſcount de Querhoent ſaw ſome 50 leagues off the coaſts of Portugal on the 17th of April. They were ſo fatigued, that they ſuffered themſelves to be caught by the hand (A). Gmelin found theſe birds in the countries watered by the Don. Belon calls them *black rails*, and ſays they are everywhere known, and that the ſpecies is more numerous than the red rail, or land rail. The fleſh of the water rail is not ſo delicate as that of the land rail, and has even a marſhy taſte, nearly like that of the gallinule. It continues the whole year in England."

2. The porzana, or gallinule, is not very frequent in Great Britain, and is ſaid to be migratory. Inhabits the ſides of ſmall ſtreams, concealing itſelf among the buſhes. Its length is nine inches; its breadth, 15; its weight, four ounces five drachms. The head is brown, ſpotted with black; the neck a deep olive, ſpotted with white: the feathers of the back are black next their ſhafts, then olive-coloured, and edged with white; the ſcapulars are olive, finely marked with two ſmall white ſpots on each web: the legs of a yellowiſh green. "Its habits (ſays Buffon) wild, its inſtinct ſtupid, the porzana is unſuſceptible of education, nor is even capable of being tamed. We raiſed one, however, which lived a whole ſummer on crumbs of bread and hemp-ſeed; when by itſelf, it kept conſtantly in a large bowl of water; but if a perſon entered the cloſet where it was ſhut, it ran to conceal itſelf in a ſmall dark corner, without venting cries or murmurs. In the ſtate of liberty, however, it has a ſharp piercing voice, much like the ſcream of a young bird of prey; and though it has no propenſity to ſociety, as ſoon as one cries, another repeats the ſound, which is thus conveyed through all the reſt in the diſtrict. Like all the rails, it is ſo obſtinately averſe to riſe, that the ſportſman often ſeizes it with his hand, or fells it with a ſtick. If it finds a buſh in its retreat, it climbs upon it, and from the top of its aſylum beholds the dogs bruſhing along in fault: this habit is common to it and to the water-rail. It dives, ſwims, and even ſwims under water, when hard puſhed.

"Theſe birds diſappear in the depth of winter, but return early in the ſpring; and even in the month of February they are common in ſome provinces of France and Italy. Their fleſh is delicate, and much eſteemed: thoſe, in particular, which are caught in the rice-fields in Piedmont are very fat, and of an exquiſite flavour."

3. The crex, crake, or corn-crek, has been ſuppoſed by ſome to be the ſame with the water-rail, and that it differs only by a change of colour at a certain ſeaſon of the year: this error is owing to inattention to their characters and nature, both which differ entirely. The bill of this ſpecies is ſhort, ſtrong, and thick; formed exactly like that of the water-hen, and makes a generical diſtinction. It never frequents watery places; but is always found among corn, graſs, broom, or furze. It quits the kingdom before winter; but the water-rail endures our ſharpeſt ſeaſons. They agree in their averſion to flight; and the legs, which are remarkably long for the ſize of the bird, hang down whilſt they are on the wing; they truſt their ſafety to their ſwiftneſs on foot, and ſeldom are ſprung a ſecond time but with great difficulty. The land rail lays from 12 to 20 eggs, of a dull white colour, marked with a few yellow ſpots; notwithſtanding this, they are very numerous in this kingdom. Their note is very ſingular; and like the quail, it is decoyed into a net by the imitation of its cry, *crĕk crĕk crĕk*, by rubbing hard the blade of a knife on an indented bone. Moſt of the names given in different languages to this bird are evidently formed to imitate this ſingular cry. Hence Turner and ſome other naturaliſts have ſuppoſed it to be the crex of the ancients; but that term appears to have been applied by the ancients to other birds. Philus gives the crex the epithet of βραδυπτερος, or *ſluggiſh-winged*, which would indeed ſuit the land-rail. Ariſtophanes repreſents it as migrating from Libya: Ariſtotle ſays that it is quarrelſome, which may have been attributed to it from the analogy to the quail; but he adds, that the crex ſeeks to deſtroy the neſts of the blackbird, which cannot apply to the rail, ſince it never inhabits the woods. Still leſs is the crex of Herodotus a rail, for he compares its ſize to that of the ibis, which is ten times larger. The avoſet, too, and the teal, have ſometimes the cry *crex, crex:* and the bird which Belon heard repeating that cry on the banks of the Nile is, according to his account, a ſpecies of godwit. Thus the ſound repreſented by the word *crex*, belonging to ſeveral ſpecies, is not ſufficiently preciſe to diſtinguiſh the land-rail.

Rallus ‖ Ram.

They are in greateſt plenty in Angleſea, where they appear about the 20th of April, ſuppoſed to paſs over from Ireland, where they abound: at their firſt arrival it is common to ſhoot ſeven or eight in a morning. They are found in moſt of the Hebrides, and the Orkneys. On their arrival they are very lean, weighing only ſix ounces; but before they leave this iſland, grow ſo fat as to weigh above eight. The feathers on the crown of the head and hind-part of the neck are black, edged with bay colour: the coverts of the wings of the ſame colour, but not ſpotted; the tail is ſhort, and of a deep bay: the belly white; the legs aſh-coloured.

RALPH (James), a late ingenious hiſtorical and political writer, was born, we know not when or where, being firſt known as a ſchoolmaſter in Philadelphia in North America. He came to England about the beginning of the reign of George I. and wrote ſome things in the dramatic way, which were not received with great applauſe: but though he did not ſucceed as a poet, he was a very ingenious proſe-writer. He wrote A Hiſtory of England, commencing with the Stuarts, which is much eſteemed; as were his political eſſays and pamphlets, ſome of which were looked upon as maſter-pieces. His laſt publication, The Caſe of Authors by Profeſſion, is an excellent and entertaining performance. He died in 1762.

RAM, in zoology. See Ovis.

Battering RAM, in antiquity, a military engine uſed to

(A) 'I tried (ſays M. de Querhoent) to raiſe ſome: they thrived wonderfully at firſt, but after a fortnight's confinement their long legs grew paralytic, and the birds could only crawl on their knees; at laſt they expired.' Geſner ſays, that having long fed one, he found it to be peeviſh and quarrelſome."

Ram || Rameſes.

to batter down the walls of beſieged places. See *Battering Ram*.

Ram's Head, in a ſhip, is a great block belonging to the fore and main haulyards. It has three ſhives in it, in which the haulyards are put; and in a hole at the end are reeved the ties.

RAMADAN, a ſolemn ſeaſon of faſting among the Mahometans. See Mahometanism.

RAMAH (anc. geog.), a town of Benjamin, near Gibea, (Judges); called *Rama of Saul* (1 Sam. xxii.), ſix miles from Jeruſalem to the north; memorable for the ſtory of the Levite and his concubine: Taken and fortified by Baaſa king of Iſrael, in order to annoy the kingdom of Judah. This Rama is mentioned Iſa. x. Jer. xxxi. and Matth. ii. and is to be diſtinguiſhed from *Rama of Samuel*, 1 Sam. xix. called alſo *Ramatha*, 1 Sam. i. 19. and *Ramathaim Zophim*, ibid. i. 1. which lay a great way to the weſt, towards Joppa, near Lydda, 1 Maccab. ii. the birth-place of Samuel; adjoining to the mountains of Ephraim, and the place of his reſidence, 1 Sam. xv. &c. (Joſephus). Called *Ramula* in the lower age, (Gul. Tyrius.) There is here a convent of the Fathers of the Holy Land, inhabited only by Portugueſe, Spaniards, and Italians.

RAMATH-mizpe, (Joſhua xiii.); *Ramoth-Maſpbe*, (Septuagint, Vulgate); *Ramoth in Gilead*, or *Remmath Galaad*, (Seventy); a town in that tract of Gilead called *Maſpha*, or *Mizpe*, one of the cities of refuge.

RAMAZZINI (Bernardin), an Italian phyſician, born at Carpi near Modena in 1633. He was profeſſor of phyſic in the univerſity of Modena for 18 years; and in 1700 accepted an invitation from Padua, where he was made rector of the college; and died in 1714. His works were collected and publiſhed in London, 1716; of which, his treatiſe *De Morbis Artificum*, "Of the peculiar maladies of artificers," will always be eſteemed uſeful and curious.

RAMEKINS, a fortreſs of the United Netherlands, on the ſouth coaſt of the iſland of Walchevin, in the province of Zeland. One of the cautionary towns given to Queen Elizabeth for the repayment of the charges ſhe had been at for the defence of this republic in its infancy. Four miles eaſt of Fluſhing; in N. Lat. 51. 34. E. Long. 4. 24.

RAMESES, (anc. geog.); a town built by the Iſraelites during their bondage in Egypt, and from which the Exodus took place, and which muſt have been towards and not far from the Arabian Gulph, ſeeing in the third ſtation the Iſraelites arrived on its ſhore.

RAMESES, king of the Lower Egypt when Jacob went thither with his family, in the 1706th year before the Chriſtian era. Ancient authors mention ſeveral other kings of Egypt of the ſame name; and it is thought that one of thoſe princes erected in the temple of the ſun at Thebes, the magnificent obeliſk which the emperor Conſtantine cauſed to be removed to Alexandria in the year 334; and that prince dying, his ſon Conſtantius had the obeliſk tranſported from Alexandria to Rome in 352, where it was erected in the grand Circus. Its height was 132 feet. When the Goths ſacked the city of Rome in 409, they overthrew this obeliſk, which continued buried in the ſand till the time of Sixtus V. in 1587, when it was found broken in three pieces; which being joined together, it was ſet up in the ſquare of St John de Lateran. On the four ſides of this wonderful obeliſk are a number of figures and hieroglyphical characters, which, according to the explication of Ammianus Marcellinus, contain the praiſes of Rameſes.

Ramification, Ramillies.

RAMIFICATION, the production of boughs or branches, or of figures reſembling branches.

RAMILLIES, a ſmall village of Brabant, in the Auſtrian Low Countries, 12 miles north of Namur, and 22 ſouth-eaſt of Bruſſels. Lat. 50. 51. Long. 4. 48. Famous for the battle fought by the allies commanded by the duke of Marlborough and M. D'Auverquirque, againſt that of the two crowns, commanded by the Duke of Bavaria and Marſhal Villeroy, the 22d of May 1706. See Britain, n° 357.

The troops deſtined to compoſe the army of the allies being joined at the camp of Borchloon the 20th of May, halted the 21ſt. On the 22d the army marched from Borchloon in four columns, and poſted itſelf the ſame day, with the right towards the Mill of Quorem, extending with the left towards Blehen: from this camp was diſcovered the army of the two crowns, which was encamped with the left at Over-Eſpen, and the right towards the wood of Chapiaraux, Heyliſſem in their front, and Tirlemont in their rear. It was reſolved the ſame day to march the next morning towards the plain of Meerdorp or Mierdau, to view the poſture of the enemies, and determine what would be the moſt proper means of attacking them according to the movement they ſhould make. To this end, an advanced guard of 600 horſe and all the quarter-maſters of the army were ſent forward on the 23d at break of day.

The ſame morning about four, the army marched in eight columns towards the aforeſaid plain. The advanced guard and the quarter-maſters arrived about eight at the height of Meerdorp or Mierdau; from whence the army of the enemy was ſeen in motion: a little after it was perceived that the enemy was marching through the plain of Mount St Andrew in four columns, of which information was given to the duke of Marlborough and M. D'Auverquirque, who immediately repaired to the ſaid height; and by the time theſe generals were arrived there, the head of the enemy's army already appeared at the tomb of Ottomont upon the cauſeway, near the Mehaigne: whereupon the Duke of Marlborough and M. D'Auverquirque made the army advance with all expedition.

The enemy, as faſt as they advanced, ranged in order of battle, with their right towards the tomb of Ottomont upon the Mehaigne, extending with their left to Autr'Egliſe; having Tranquiers in front of their right, into which they had thrown ſeveral battalions of infantry and 14 ſquadrons of dragoons, who had diſmounted their horſes to ſupport them. They had placed many of their infantry and a conſiderable part of their artillery in the village of Ramillies, which fronted the right of their main body, as well as into the village of Offuz, which fronted the left of their infantry, and into the village of Autr'Egliſe, quite on their left. The front between the village of Ramillies and Autr'Egliſe was covered by a ſmall ſtream of water, which rendered the meadows in ſome places marſhes, and alſo by ſeveral roads covered with hedges; which difficulties prevented our cavalry of the right wing from coming to action. As faſt as the army of the allies arrived it was ranged in order of battle; with the left towards

Bonnef,

Ramillies || Rampart.

Bonnef, and the right towards Folz, and every thing was diſpoſed in order to attack. To this end, four battalions were detached to attack the village of Franquenies, and twelve battalions to attack the village of Ramillies, which were to be ſupported by the whole infantry.

Our artillery began to cannonade the enemy at one; at about two, the attack began with the poſt of Franquenies, where our infantry had the good fortune to drive the enemy from the hedges, where they were advantageouſly poſted, and at the ſame time all the cavalry of our left wing advanced to attack that of the enemy's right; ſoon after all was in action. Whilſt the cavalry were engaged, the village of Ramillies was likewiſe attacked, and forced after a vigorous reſiſtance.

The battle laſted about two hours, and was pretty obſtinate; but ſo ſoon as our cavalry had gained ground enough to attack the enemy in flank, they began to give way; at the ſame time all their infantry were put in diſorder, ſo that the whole retreated in great confuſion. The cavalry of their left wing formed a little upon the high ground, between Offuz and Mount St Andrew, to favour their retreat: but after the infantry and cavalry of our right wing had filed off between the bottom of the village of Ramillies and Offuz, the whole army marched in ſeveral columns to attack the enemy anew; but they gave way before we could come up with them, and retired in great confuſion, ſome towards the defile of the Abbey De La Ramée and towards Dongelberge, others towards Judogne, and others again towards Hougarde. They were purſued all night ſo cloſely that they were obliged to abandon all their artillery and baggage, part of which was found at Judogne and at Hougarde, with their cheſts of ammunition.

The enemy loſt above 30,000 men, 60 cannon, 8 mortars, ſtandards, colours, baggage, &c.; we about 3000. The reſt of the campaign was ſpent in the ſieges of Oſtend, Menin, and Aeth. In fourteen days the Duke defeated and diſperſed the beſt appointed army the French ever had, and recovered all Spaniſh Brabant, the marquiſate of the holy Roman empire. The army of the enemy conſiſted of 76 battalions and 142 ſquadrons, including the king's houſhold troops (*La Maiſon du Roi*); and the army of the allies was 74 battalions and 123 ſquadrons. Conſidering the importance of the victory, the loſs of the allies was very ſmall, not above 1100 being killed, and 2600 wounded.

RAMLA, the modern name of Arimathea. See ARIMATHEA.

RAMMER, an inſtrument uſed for driving down ſtones or piles into the ground; or for beating the earth, in order to render it more ſolid for a foundation.

Rammer of a Gun, the *Gun-ſtick*; a rod uſed in charging of a gun, to drive home the powder, as alſo the ſhot, and the wad which keeps the ſhot from rolling out.

RAMPANT, in heraldry, a term applied to a lion, leopard, or other beaſt that ſtands on its hind legs, and rears up his fore-feet in the poſture of climbing, ſhowing only half his face, as one eye, &c. It is different from ſaliant, in which the beaſt ſeems ſpringing forward as if making a ſally.

RAMPART, in fortification, is an elevation of earth round a place capable of reſiſting the cannon of an enemy; and formed into baſtions, curtins, &c.

RAMPHASTOS, the TOUCAN, in ornithology. See RHAMPHASTOS.

Ramphaſtos. Ramſay.

RAMSAY (Allan), the Scots paſtoral poet, was a barber in Edinburgh in the early part of the preſent century. His taſte in poetry, however, has juſtly raiſed him to a degree of fame that may in ſome meaſure be conſidered as a recompenſe for the frowns of fortune. His ſongs are in univerſal eſteem; as is alſo the only dramatic performance attributed to him, viz. *Patie and Roger*, or *The Gentle Shepherd*, a Scots paſtoral. He died in 1743; and was father to the ingenious Mr Ramſay, a celebrated painter of the preſent age, and who has likewiſe diſtinguiſhed himſelf by ſome well-written tracts on various branches of polite literature, particularly the *Inveſtigator*.

RAMSAY (Andrew Michael), generally known by the name of the *Chevalier Ramſay*, was a polite Scots writer, born of a good family at Ayr in 1686. His good parts and learning recommended him to be tutor to the ſon of the earl of Wemyſs; after which, conceiving a diſguſt at the religion in which he had been educated, he in the ſame ill humour reviewed other Chriſtian churches; and, finding none to his liking, reſted for a while in Deiſm. While he was in this uncertain ſtate of mind, he went to Leyden; where, falling into the company of one Poiret a myſtic divine, he received the infection of myſticiſm: which prompted him to conſult M. Fenelon, the celebrated archbiſhop of Cambray, who had imbibed principles of the ſame nature; and who gained him over to the Catholic religion in 1709. The ſubſequent courſe of his life received its direction from his friendſhip and connections with this prelate; and being appointed governor to the duke de Chateau Thierry, and the prince de Turenne, he was made a knight of the order of St Lazarus. He was ſent for to Rome by the chevalier de St George, to undertake the education of his children; but he found ſo many intrigues and diſſenſions on his arrival there in 1724, that he obtained the Chevalier's leave to return to Paris. He died in 1743, in the office of intendant to the duke of Bouillon, prince de Turenne. The moſt capital work of his writing is the *Travels of Cyrus*, which has been ſeveral times printed in Engliſh.

RAMSAY (the Reverend James), ſo juſtly celebrated for his philanthropy, was, on the 25th of July 1733, born at Fraſerſburgh, a ſmall town in the county of Aberdeen, North Britain. His deſcent was honourable, being, through his father, from the Ramſays of Melroſe in Banffſhire, and through his mother, from the Ogilvies of Purie in Angus. His parents were of characters the moſt reſpectable, but in circumſtances by no means affluent. From his earlieſt years he diſcovered a ſerious diſpoſition, and a ſtrong thirſt for knowledge; and after paſſing through the courſe of a Scotch grammar ſchool education, he was inclined to purſue the ſtudies requiſite to fit him for the profeſſion of a clergyman; an inclination with which the wiſhes of his mother, a woman of eminent piety, powerfully concurred. Several circumſtances, however, conſpired to divert him for a time from his favourite purſuit.

He was educated in the epiſcopal perſuaſion; and having been unhappy enough to loſe his father while yet very young, he found, upon his advancing towards the ſtate of manhood, that the joint fortunes of himſelf and his

Ramſay. his mother could not bear the expence of a regular education in either of the univerſities of Oxford or Cambridge, which he doubtleſs thought abſolutely neceſſary to one who aſpired to reſpectability in the church of England. Yielding therefore to neceſſity, he reſolved to ſtudy ſurgery and pharmacy; and was with this view bound apprentice to Dr Findlay, a phyſician (A) in Fraſerſburgh. But though obliged to relinquiſh for a time his favourite ſtudies, he did not think ignorance excuſable in a ſurgeon more than in a clergyman, or conceive that he could ever become eminent in the profeſſion in which circumſtances had placed him, merely by ſkill in ſetting a bone or compounding a medicine. He determined therefore, with the full approbation of his maſter, who very ſoon diſcovered his talents for literature, to make himſelf acquainted with at leaſt the outlines of the liberal arts and ſciences; and with this view he repaired in 1750 to the King's College and univerſity of Aberdeen, where he obtained one of the *burſaries* or *exhibitions* which are there annually beſtowed upon ſuch candidates for them as diſplay the moſt accurate knowledge of the Latin language. The ſmall ſum of five pounds, however (which none of theſe burſaries exceed), was ſtill inadequate to the expence of reſidence in college; but our young ſtudent was ſoon to obtain a more valuable exhibition, and to obtain it likewiſe by his own merit.

During the long vacation he returned to his maſter Dr Findlay, and was by him intruſted with a very deſperate caſe in ſurgery, of which his management may be ſaid to have laid the foundation of his future fortunes. A female ſervant of one of the judges of the Court of Seſſion, who, when the court was not ſitting, reſided in the neighbourhood of Fraſerſburgh, had been ſo dreadfully gored by a bull, that hardly any hopes were entertained of her recovery; but Mr Ramſay, to whoſe care ſhe was entirely left, treated the wound with ſuch ſkilful attention, that, contrary to general expectation, his patient recovered. This attracted the judge's notice, who having informed himſelf of the young man's circumſtances and character, recommended him ſo effectually to Sir Alexander Ramſay of Balmain, that he preſented him with a burſary of 15 pounds a-year, which commenced at the next *ſeſſion* or *term*, in the ſame college.

He now proſecuted his ſtudies with comfort; and though he was detained in college a year longer than is uſual, being obliged, upon his acceptance of a ſecond burſary, to begin his courſe anew, he always conſidered this as a fortunate circumſtance, becauſe it gave him the celebrated Dr Reid three years for his preceptor. To that great and amiable philoſopher he ſo recommended himſelf by his talents, his induſtry, and his virtues, that he was honoured with his friendſhip to the day of his death. Nor was it only to his maſters that his conduct recommended him; Sir Alexander Ramſay, whom he viſited during ſome of the vacations, was ſo well pleaſed with his converſation, that he promiſed him another burſary, in his gift, of 25l. a-year, to commence immediately on the expiration of that which he enjoyed. This promiſe he performed in the beginning of the year 1755; and at the ſolicitation of Dr Findlay even paid the money per advance to enable the exhibitioner to travel for the purpoſe of improving himſelf in his profeſſion. Ramſay.

Thus provided, Mr Ramſay went to London, and ſtudied ſurgery and pharmacy under the auſpices of Dr Macauly; in whoſe family he lived for two years, careſſed and eſteemed both by him and by his lady. Afterwards, having paſſed the uſual examination at Surgeon's-hall, he ſerved in his medical capacity for ſeveral years in the royal navy; but how long he was continued in the ſtation of a mate, or when and by whom he was firſt appointed ſurgeon, we have not been able to learn. We can ſay, however, upon the beſt authority, that by his humane and diligent diſcharge of his duty in either ſtation, he endeared himſelf to the ſeamen, and acquired the eſteem of his officers.

Of his humanity there is indeed one memorable inſtance, which muſt not be omitted. Whilſt he acted as ſurgeon of the Arundel, then commanded by Captain (now Vice-admiral Sir Charles) Middleton, a ſlave-ſhip on her paſſage from Africa to the Weſt Indies fell in with the fleet to which the Arundel belonged. An epidemical diſtemper, too common in ſuch veſſels, had ſwept away not only a great number of the unfortunate negroes, but alſo many of the ſhip's crew, and among others the ſurgeon. In this diſtreſſed ſituation the commander of the Guinea ſhip applied to the Engliſh Commodore for medical aſſiſtance; but not a ſurgeon or ſurgeon's mate in the whole fleet, except Mr Ramſay, would expoſe himſelf to the contagion of ſo dangerous a diſtemper. Prompted, however, by his own innate benevolence, and fully authorized by his no leſs benevolent commander, the ſurgeon of the Arundel, regardleſs of perſonal danger, and truſting in that God to whom mercy is more acceptable than ſacrifice, went on board the infected ſhip, viſited all the patients, and remained long enough to leave behind him written directions for their future treatment. If a cup of cold water given in charity be entitled to a reward, how much more ſuch an action as this? But the rewards of Chriſtianity are not immediate. Mr Ramſay indeed eſcaped the contagion; but on his return to his own ſhip, juſt as he had got on the deck, he fell and broke his thigh-bone; by which he was confined to his apartment for ten months, and rendered in a ſmall degree lame through the remainder of his life.

The fearleſs humanity which he diſplayed on this occaſion gained him the friendſhip and eſteem of Sir Charles Middleton, which no future action of his life had the ſmalleſt tendency to impair; but the fracture of his thigh-bone and his ſubſequent lameneſs determined him to quit the navy, and once more turn his thoughts towards the church. Accordingly, while the Arundel lay at St Chriſtopher's, he opened his views to ſome

(A) In the remote towns of Scotland the ſame man generally acts in the triple capacity of phyſician, ſurgeon, and apothecary; and we could mention doctors of phyſic of the firſt eminence, who practiſe thus within forty miles of Edinburgh.

Ramsay. some of the principal inhabitants of that island, by whom he was so strongly recommended to the bishop of London, that on his coming home with Sir Charles Middleton, who warmly joined in the recommendation, he was admitted into orders; after which he immediately returned to St Christopher's, where he was presented by the governor to two rectories, valued at 700l. a-year.

As soon as he took possession of his livings, in 1763, he married Miss Rebecca Akers, the daughter of a planter of the best family-connections in the island, and began to regulate his household on the pious plan inculcated in his *Essay on the Treatment and Conversion of the African Slaves in the British Sugar Colonies*. He summoned all his own slaves daily to the prayers of the family, when he took an opportunity of pointing out to them their duty in the plainest terms, reproving those that had done amiss, and commending such as had shown any thing like virtue; but he confessed that his occasions for reproof were more frequent than for commendation. As became his office and character, he inculcated upon others what he practised himself, and knew to be equally the duty of all. "On his first settlement as a minister in the West Indies, he made some public attempts to instruct slaves. He began to draw up some easy, plain discourses for their instruction. He invited them to attend on Sundays, at particular hours. He appointed hours at home to instruct such sensible slaves as would of themselves attend. He repeatedly exhorted their masters to encourage such in their attendance. He recommended the French custom, of beginning and ending work by prayer. But inconceivable is the listlessness with which he was heard, and bitter was the censure heaped on him in return. It was quickly suggested, and generally believed, that he wanted to interrupt the work of slaves, to give them time, forsooth, to say their prayers; that he aimed at the making of them Christians, to render them incapable of being good slaves. In one word, he stood, in opinion, a rebel convict against the interest and majesty of plantership. And as the Jews say, that in every punishment, with which they have been proved, since the bondage of Egypt, there has been an ounce of the golden calf of Horeb; so might he say, that in every instance of prejudice (and they were not a few) with which, till within a year or two of his departure from the country, he was exercised, there was an ounce of his fruitless attempts to improve the minds of slaves. In the bidding prayer, he had inserted a petition for the conversion of those persons. But it was deemed so disagreeable a memento, that several white people, on account of it, left off attending divine service. He was obliged to omit the prayer entirely, to try and bring them back. In short, neither were the slaves, at that time, desirous of being taught, nor were their masters inclined to encourage them."

That he was hurt by this neglect cannot be questioned, for he had a mind benevolent, warm, and irritable; but he still retained many friends amongst the most worthy members of the community: and as he was conscious of having done nothing more than his duty, he consoled himself with reflecting, that those are "blessed whom men revile, and persecute, and speak all manner of evil against falsely, for the sake of the gospel."

Although his serious studies were now theological, he considered himself as answerable to God, his country, and his own family, for a proper use of every branch of knowledge which he possessed. He therefore took the charge of sever al plantations around him in the capacity of a medical practitioner; and attended them with unremitting diligence, and with great success. Thus he lived till the year 1777, when relinquishing the practice of physic entirely, he paid a visit to the place of his nativity, which he had not seen since 1755. His mother, whose latter days he had made comfortable by a handsome annuity, had been dead for some years; but he rewarded all who had been attentive to her, or in early life serviceable to himself; and he continued the pension to a sister who had a numerous family, for which her husband was unable to provide. Ramsay.

After remaining three weeks in Scotland, and near a year in England, during which time he was admitted into the confidence of Lord George Germaine, secretary of state for the American department, Mr Ramsay was appointed chaplain to Admiral Barrington, then going out to take a command in the West Indies. Under this gallant officer, and afterwards under Lord Rodney, he was present at several engagements, where he displayed a fortitude and zeal for the honour of his country which would not have disgraced the oldest admiral. To the navy, indeed, he seems to have been strongly attached; and he wrote, at an early period of his life, an *Essay on the Duty and Qualifications of a Sea-officer*, with such a knowledge of the service as would have done honour to the pen of the most experienced commander. Of the first edition of this essay the profits were by its benevolent author appropriated to the Magdalen and British lying-in hospitals, as those of the second and third (which last was published about the period of which we now write) were to the maritime school, or, in the event of its failure, to the marine society.

Although caressed by both the admirals under whom he served, and having such influence with the latter as to be able to render essential services to the Jews and other persons whom he thought harshly treated at the capture of St Eustatius, Mr Ramsay once more quitted the sea-service, and retired to his pastoral charge in the Island of St Christopher's. There, however, though the former animosities against him had entirely subsided, and though his friendship was now solicited by every person of consequence in the island, he remained but a little while. Sick of the life of a planter and of the prospect of slavery around him, he resigned his livings, bade adieu to the island, and returned to England with his wife and family in the end of the year 1781. Immediately on his arrival, he was, through the interest of his steady friend Sir Charles Middleton, presented to the livings of Teston and Nettlestead in the county of Kent.

Here he was soon determined, by the advice of those whom he most respected, to publish an *Essay*, which had been written many years before, *on the Treatment and Conversion of African Slaves in the British Sugar Colonies*. The controversy in which this publication involved him, and the acrimony with which it was carried on, are so fresh in the memory of all our readers, that no man who thinks of the narrow limits within which our biographical articles must be confined, will blame us for not entering into a detail of the particulars.—Torrents of obloquy were poured upon the benevolent author by writers who were unfair enough to conceal their

Ramſay. Ramſden's Machine.

their names; and it muſt be confeſſed, that his replies abounded with ſarcaſms, which the moſt rational friends to the cauſe which he ſupported would not have been ſorry to ſee blotted from his pages. The provocation, however, which he received was great; and Mr Ramſay, though an amiable, virtuous, and pious man, had a warmth of temper, which, though not deſerving of praiſe, will be cenſured by none who reflect on the frailties of our common nature. That the particular calumnies propagated againſt him on this occaſion were wholly groundleſs, it is impoſſible to doubt, if we admit him to have been poſſeſſed of common underſtanding. When ſome years ago a ſtory was circulated, of Swift's having, when prebendary of Kilroot, been convicted before a magiſtrate of an attempt to commit a rape on the body of one of his pariſhioners, it was thought a ſufficient confutation of the calumny to put the retailer of it in mind, that the dean of St Patrick's, though deteſted by the moſt powerful faction in the kingdom, lampooned without dread, and with great ſeverity, the dean of Ferns for the very crime of which, had this anecdote been true, he muſt have been conſcious that all Ireland knew himſelf to be guilty! Such conduct cannot be reconciled to common ſenſe. Had Swift been a raviſher, though he might have been penitent, and reaſoned in general terms againſt giving way to ſuch licentious paſſions, he would never have ſatyriſed a *particular perſon* for the crime of which he himſelf ſtood convicted. In like manner, had Mr Ramſay been a tyrant to his own ſlaves, though he might have argued againſt ſlavery in the abſtract, on the broad baſis of virtue and religion, he never could have arraigned for ſimilar cruelty a number of individuals in the very iſland which witneſſed his own enormities.

But the melancholy part of the narrative is behind. The agitation given to his mind by theſe calumnies, and the fatigues he underwent in his endeavours to reſcue from miſery the moſt helpleſs portion of the human race, contributed to ſhorten a life in no common degree uſeful. He had been for ſome time afflicted with a pain in his ſtomach, for which he was prevailed upon, tho' with great reluctance, to try the effects of air and exerciſe, by attempting a journey of 100 miles. But in London, being ſeized with a violent vomiting of blood, he was unable either to proceed or to be removed home; and in the houſe of Sir Charles Middleton he ended his days, on the 20th of July 1789, amidſt the groans of his family, and the tears of many friends.—Thus died a man, of whom it is not too much to ſay, that "the bleſſing of many that were ready to periſh came upon him;" for whatever be the fate of the ſlave-trade (ſee SLAVERY), it is certain that his writings have contributed much to meliorate the treatment of ſlaves. He left behind him a widow and three daughters: and his works, beſides thoſe to which we have alluded, conſiſt of a volume of *Sea-ſermons*, preached on board his majeſty's ſhip the Prince of Wales, which ſhow him to have been a maſter of true pulpit-eloquence; and a *Treatiſe on Signals*, which was certainly written, and we think printed, though we know not whether it was ever publiſhed.

RAMSDEN's MACHINE *for Dividing* MATHEMATICAL INSTRUMENTS, is a late invention, by which theſe diviſions can be performed with exceeding great accuracy, ſuch as would formerly have been deemed incredible. On diſcovering the method of conſtructing this machine, its inventor, Mr Ramſden of Piccadilly, received 615 l. from the commiſſioners of longitude; engaging himſelf to inſtruct a certain number of perſons, not exceeding ten, in the method of making and uſing this machine from the 28th October 1775 to 28th October 1777; alſo binding himſelf to divide all octants and ſextants by the ſame engine, at the rate of three ſhillings for each octant, and ſix ſhillings for each braſs ſextant, with Nonius's diviſions to half minutes, for as long time as the commiſſioners ſhould think proper to let the engine remain in his poſſeſſion. Of this ſum of 615 l. paid to Mr Ramſden, 300 l. was given him as a reward for the improvement made by him in diſcovering the engine, and the remaining 315 l. for his giving up the property of it to the commiſſioners. The following deſcription of the engine, is that given upon oath by Mr Ramſden himſelf. Ramſden's Machine.

"This engine conſiſts of a large wheel of bell-metal, ſupported on a mahogany ſtand, having three legs, which are ſtrongly connected together by braces, ſo as to make it perfectly ſteady. On each leg of the ſtand is placed a conical friction-pulley, whereon the dividing-wheel reſts: to prevent the wheel from ſliding off the friction-pulleys, the bell-metal centre under it turns in a ſocket on the top of the ſtand.

"The circumference of the wheel is ratched or cut (by a method which will be deſcribed hereafter) into 2160 teeth, in which an endleſs ſcrew acts. Six revolutions of the ſcrew will move the wheel a ſpace equal to one degree.

"Now a circle of braſs being fixed on the ſcrew arbor, having its circumference divided into 60 parts, each diviſion will conſequently anſwer to a motion of the wheel of 10 ſeconds, ſix of them will be equal to a minute, &c.

"Several different arbors of tempered ſteel are truly ground into the ſocket in the centre of the wheel. The upper parts of the arbors that ſtand above the plane are turned of various ſizes, to ſuit the centres of different pieces of work to be divided.

"When any inſtrument is to be divided, the centre of it is very exactly fitted on one of theſe arbors; and the inſtrument is fixed down to the plane of the dividing wheel, by means of ſcrews, which fit into holes made in the radii of the wheel for that purpoſe.

"The inſtrument being thus fitted on the plane of the wheel, the frame which carries the dividing-point is connected at one end by finger-ſcrews with the frame which carries the endleſs ſcrew; while the other end embraces that part of the ſteel arbor, which ſtands above the inſtrument to be divided, by an angular notch in a piece of hardened ſteel; by this means both ends of the frame are kept perfectly ſteady and free from any ſhake.

"The frame carrying the dividing-point or tracer, is made to ſlide on the frame which carries the endleſs ſcrew to any diſtance from the centre of the wheel as the radius of the inſtrument to be divided may require, and may be there faſtened by tightening two clamps; and the dividing-point or tracer being connected with the clamps by the double-jointed frame, admits a free and eaſy motion towards or from the centre for cutting the diviſions, without any lateral ſhake.

"From what has been ſaid, it appears, that an inſtrument

Ramſden's Machine.

ſtrument thus fitted on the dividing-wheel may be moved to any angle by the ſcrew and divided circle on its arbor, and that this angle may be marked on the limb of the inſtrument with the greateſt exactneſs by the dividing-point or tracer, which can only move in a direct line tending to the centre, and is altogether freed from thoſe inconveniences that attend cutting by means of a ſtraight edge. This method of drawing lines will alſo prevent any error that might ariſe from an expanſion or contraction of the metal during the time of dividing.

"The ſcrew-frame is fixed on the top of a conical pillar, which turns freely round its axis, and alſo moves freely towards or from the centre of the wheel, ſo that the ſcrew-frame may be entirely guided by the frame which connects it with the centre: by this means any excentricity of the wheel and the arbor would not produce any error in the dividing; and, by a particular contrivance (which will be deſcribed hereafter), the ſcrew when preſſed againſt the teeth of the wheel always moves parallel to itſelf; ſo that a line joining the centre of the arbor and the tracer continued, will always make equal angles with the ſcrew.

Plate CCCCXXXIII "Figure 1. repreſents a perſpective view of the engine.

Plate CCCCXXXIV "Fig. 2. is a plan, of which fig. 3. repreſents a ſection on the line IIA.

"The large wheel A is 45 inches in diameter, and has ten radii, each being ſupported by edge-bars, as repreſented in fig. 3. Theſe bars and radii are connected by the circular ring B, 24 inches in diameter and 3 deep; and, for greater ſtrength, the whole is caſt in one piece in bell-metal.

"As the whole weight of the wheel A reſts on its ring B, the edge-bars are deepeſt where they join it; and from thence their depth diminiſhes, both towards the centre and the circumference, as repreſented in fig. 3.

"The ſurface of the wheel A was worked very even and flat, and its circumference turned true. The ring C, of fine braſs, was fitted very exactly on the circumference of the wheel; and was faſtened thereon with ſcrews, which, after being ſcrewed as tight as poſſible, were well rivetted. The face of a large chuck being turned very true and flat in the lath, the flattened ſurface A of the wheel was faſtened againſt it with hold-faſts; and the two ſurfaces and circumference of the ring C, a hole through the centre and the plane part round (b) it, and the lower edge of the ring B, were turned at the ſame time. Fig. 3.

"D is a piece of hard bell-metal, having the hole, which receives the ſteel-arbor (d), made very ſtraight and true. This bell-metal was turned very true on an arbor; and the face, which reſts on the wheel at (b), was turned very flat, ſo that the ſteel arbor (d) might ſtand perpendicular to the plane of the wheel: this bell-metal was faſtened to the wheel by ſix ſteel ſcrews (l).

"A braſs ſocket Z is faſtened on the centre of the mahogany ſtand, and receives the lower part of the bell-metal piece D, being made to touch the bell-metal in a narrow part near the mouth, to prevent any obliquity of the wheel from bending the arbor: good fitting is by no means neceſſary here; ſince any ſhake in this ſocket will produce no bad effect, as will appear hereafter when we deſcribe the cutting frame. Ramſden's Machine.

"The wheel was then put on its ſtand, the lower edge of the ring B reſting on the circumference of three conical friction-pulleys W, to facilitate its motion round its centre. The axis of one of theſe pulleys is in a line joining the centre of the wheel and the middle of the endleſs ſcrew, and the other two placed ſo as to be at equal diſtances from each other. Fig. 1, 2, and 3.

"F is a block of wood ſtrongly faſtened to one of the legs of the ſtand; the piece (g) is ſcrewed to the upper ſide of the block, and has half holes, in which the tranſverſe axis (h) turns: the half holes are kept together by the ſcrews (i). Fig. 1. Fig. 4.

"The lower extremity of the conical pillar P terminates in a cylindrical ſteel-pin (k), which paſſes through and turns in the tranſverſe axis (h), and is confined by a cheek and ſcrew. Fig. 1. & 4. Fig. 4.

"To the upper end of the conical pillar is faſtened the frame G, in which the endleſs ſcrew turns: the pivots of the ſcrew are formed in the manner of two fruſtums of cones joined by a cylinder, as repreſented at X. Theſe pivots are confined between half poles, which preſs only on the conical parts, and do not touch the cylindric parts: the half holes are kept together by ſcrews (a), which may be tightened at any time, to prevent the ſcrew from ſhaking in the frame. Fig. 4. Fig. 5.

"On the ſcrew-arbor is a ſmall wheel of braſs K, having its outſide edge divided into 60 parts, and numbered at every 6th diviſion with 1, 2, &c. to 10. The motion of this wheel is ſhown by the index (y) on the ſcrew-frame G. Fig. 1, 2, 4, 5. Fig. 4. & 5.

"H repreſents a part of the ſtand, having a parallel ſlit in the direction towards the centre of the wheel, large enough to receive the upper part of the conical braſs pillar P, which carries the ſcrew and its frame: and as the reſiſtance, when the wheel is moved by the endleſs ſcrew, is againſt that ſide of the ſlit H which is towards the left hand, that ſide of the ſlit is faced with braſs, and the pillar is preſſed againſt it by a ſteel ſpring on the oppoſite ſide: by this means the pillar is ſtrongly ſupported laterally, and yet the ſcrew may be eaſily preſſed from or againſt the circumference of the wheel, and the pillar will turn freely on its axis to take any direction given it by the frame L. Fig. 1.

"At each corner of the piece I are ſcrews (n) of tempered ſteel, having poliſhed conical points: two of them turn in conical holes in the ſcrew-frame near (o), and the points of the other two ſcrews turn in holes in the piece Q; the ſcrews (p) are of ſteel, which being tightened, prevent the conical pointed ſcrews from unturning when the frame is moved. Fig. 4.

"L is a braſs frame, which ſerves to connect the endleſs ſcrew, its frame, &c. with the centre of the wheel: each arm of this frame is terminated by a ſteel ſcrew, that may be paſſed through any of the holes (q) in the piece Q, as the thickneſs of work to be divided on the wheel may require, and are faſtened by the finger-nuts (r). Fig. 1, 2, 6. Fig. 4. Fig. 1. & 2.

"At the other end of this frame is a flat piece of tempered ſteel (b), wherein is an angular notch: when the endleſs ſcrew is preſſed againſt the teeth on the circumference of the wheel, which may be done by turning the finger-ſcrew S, to preſs againſt the ſpring (t), Fig. 6. Fig. 1. & 2.

Ramſden's Machine.

this notch embraces and preſſes againſt the ſteel arbor (d). This end of the frame may be raiſed or depreſſed by moving the priſmatic ſlide (u), which may be fixed at any height by the four ſteel-ſcrews (v).

Fig. 2.

Fig. 1, 2, 6.

Fig. 1. & 6.

" The bottom of this ſlide has a notch (k), whoſe plane is parallel to the endleſs-ſcrew; and by the point of the arbor (d) reſting in this notch, this end of the frame is prevented from tilting. The ſcrew S is prevented from unturning, by tightening the finger-nut (w).

Fig. 3.

Fig. 1, 2.

" The teeth on the circumference of the wheel were cut by the following method:

" Having conſidered what number of teeth on the circumference would be moſt convenient, which in this engine is 2160, or 360 multiplied by 6, I made two ſcrews of the ſame dimenſions, of tempered ſteel, in the manner hereafter deſcribed, the interval between the threads being ſuch as I knew by calculation would come within the limits of what might be turned off the circumference of the wheel: one of theſe ſcrews, which was intended for ratching or cutting the teeth, was notched acroſs the threads, ſo that the ſcrew, when preſſed againſt the edge of the wheel and turned round, cut in the manner of a ſaw. Then having a ſegment of a circle a little greater than 60 degrees, of about the ſame radius with the wheel, and the circumference made true, from a very fine centre, I deſcribed an arch near the edge, and ſet off the chord of 60 degrees on this arch. This ſegment was put in the place of the wheel, the edge of it was ratched, and the number of revolutions and parts of the ſcrew contained between the interval of the 60 degrees were counted. The radius was corrected in the proportion of 360 revolutions, which ought to have been in 60 degrees, to the number actually found; and the radius, ſo corrected, was taken in a pair of beam-compaſſes: while the wheel was on the lath, one foot of the compaſſes was put in the centre, and with the other a circle was deſcribed on the ring; then half the depth of the threads of the ſcrew being taken in dividers, was ſet from this circle outwards, and another circle was deſcribed cutting this point; a hollow was then turned on the edge of the wheel of the ſame curvature as that of the ſcrew at the bottom of the threads: the bottom of this hollow was turned to the ſame radius or diſtance from the centre of the wheel, as the outward of the two circles before-mentioned.

" The wheel was now taken off the lath; and the bell-metal piece D was ſcrewed on as before directed, which after this ought not to be removed.

Fig. 3.

" From a very exact centre a circle was deſcribed on the ring C, about $\frac{4}{10}$ of an inch within where the bottom of the teeth would come. This circle was divided with the greateſt exactneſs I was capable of, firſt into five parts, and each of theſe into three. Theſe parts were then biſected four times: (that is to ſay) ſuppoſing the whole circumference of the wheel to contain 2160 teeth, this being divided into five parts, each would contain 432 teeth; which being divided into three parts, each of them would contain 144; and this ſpace biſected four times would give 72, 36, 18, and 9: therefore each of the laſt diviſions would contain nine teeth. But, as I was apprehenſive ſome error might ariſe from quinqueſection and triſection, in order to examine the accuracy of the diviſions, I deſcribed another circle on the ring C, $\frac{1}{10}$ inch within the former, and divided it by continual biſections, as 2160, 1080, 540, 270, 135, $67\frac{1}{2}$, and $33\frac{3}{4}$; and as the fixed wire (to be deſcribed preſently) croſſed both the circles, I could examine their agreement at every 135 revolutions; (after ratching, could examine it at every $33\frac{3}{4}$): but, not finding any ſenſible difference between the two ſets of diviſions, I, for ratching, made choice of the former; and, as the coincidence of the fixed wire with an interſection could be more exactly determined than with a dot or diviſion, I therefore made uſe of interſections in both circles before deſcribed.

Ramſden's Machine.

Fig. 7.

" The arms of the frame L were connected by a thin piece of braſs of $\frac{1}{4}$ of an inch broad, having a hole in the middle of $\frac{4}{10}$ of an inch in diameter; acroſs this hole a ſilver wire was fixed exactly in a line to the centre of the wheel; the coincidence of this wire with the interſections was examined by a lens $\frac{7}{10}$ inch focus, fixed in a tube which was attached to one of the arms L (A). Now a handle or winch being fixed on the end of the ſcrew, the diviſion marked 10 on the circle K was ſet to its index, and, by means of a clamp and adjuſting ſcrew for that purpoſe, the interſection marked 1 on the circle C was ſet exactly to coincide with the fixed wire; the ſcrew was then carefully preſſed againſt the circumference of the wheel, by turning the finger-ſcrew S; then, removing the clamp, I turned the ſcrew by its handle 9 revolutions, till the interſection marked 240 came nearly to the wire; then, unturning the finger-ſcrew S, I releaſed the ſcrew from the wheel, and turned the wheel back till the interſection marked 2 exactly coincided with the wire, and, by means of the clamp before-mentioned, the diviſion 10 on the circle being ſet to its index, the ſcrew was preſſed againſt the edge of the wheel by the finger-ſcrew S; the clamps were removed, and the ſcrew turned nine revolutions till the interſection marked 1 nearly coincided with the fixed wire; the ſcrew was releaſed from the wheel by unturning the finger-ſcrew S as before, the wheel was turned back till the interſection 3 coincided with the fixed wire; the diviſion 10 on the circle being ſet to its index, the ſcrew was preſſed againſt the wheel as before, and the ſcrew was turned 9 revolutions, till the interſection 2 nearly coincided with the fixed wire, and the ſcrew was releaſed; and I proceeded in this manner till the teeth were marked round the whole circumference of the wheel. This was repeated three times round, to make the impreſſion of the ſcrew deeper. I then ratched the wheel round continually in the ſame direction without ever diſengaging the ſcrew; and, in ratching the wheel about 300 times round, the teeth were finiſhed.

" Now it is evident, if the circumference of the wheel was even one tooth or ten minutes greater than the ſcrew would require, this error would in the firſt inſtance

(A) The interſections are marked for the ſake of illuſtration, though properly inviſible, they lying under the braſs plate.

Ramſden's Machine.

ſtance be reduced to $\frac{1}{240}$ part of a revolution, or two ſeconds and a half; and theſe errors or inequalities of the teeth were equally diſtributed round the wheel at the diſtance of nine teeth from each other. Now, as the ſcrew in ratching had continually hold of ſeveral teeth at the ſame time, and, theſe conſtantly changing, the above-mentioned inequalities ſoon corrected themſelves, and the teeth were reduced to a perfect equality. The piece of braſs which carries the wire was now taken away, and the cutting ſcrew was alſo removed, and a plain one (hereafter deſcribed) put in its place: on one end of the ſcrew is a ſmall braſs circle, having its edge divided into 60 equal parts, and numbered at every ſixth diviſion, as before-mentioned. On the other end of the ſcrew is a ratchet-wheel C, having 60 teeth,

Fig. 5. covered by the hollowed circle (d), which carries two clicks that catch upon the oppoſite ſides of the ratchet when the ſcrew is to be moved forwards. The cylinder S turns on a ſtrong ſteel arbor F, which paſſes through and is firmly ſcrewed to the piece Y: this piece, for greater firmneſs, is attached to the ſcrew-

Fig. 4. frame G by the braces (v): a ſpiral groove or thread is cut on the outſide of the cylinder S, which ſerves both for holding the ſtring, and alſo giving motion to the lever J on its centre by means of a ſteel tooth (n), that works between the threads of the ſpiral. To the lever is attached a ſtrong ſteel pin (m), on which a braſs ſocket (r) turns: this ſocket paſſes through a ſlit in the piece (p), and may be tightened in any part of the ſlit by the finger-nut (f): this piece ſerves to regulate the number of revolutions of the ſcrew for each tread of the treadle R.

Fig. 1. Fig 1. "T is a braſs box containing a ſpiral ſpring; a ſtrong gut is faſtened and turned three or four times round the crrcumference of this box; the gut then paſſes ſeveral times round the cylinder S, and from thence down to the treadle R. Now, when the treadle is preſſed down, the ſtring pulls the cylinder S round its axis, and the clicks catching hold of the teeth on the ratchet carry the ſcrew round with it, till, by the

Fig. 4. tooth (n) working in the ſpiral groove, the lever J is brought near the wheel (d), and the cylinder ſtopped by the ſcrew-head (x) ſtriking on the top of the lever J; at the ſame time the ſpring is wound up by the other end of the gut paſſing round the box T. Now,

Fig. 1. when the foot is taken off the treadle, the ſpring unbending itſelf pulls back the cylinder, the clicks leaving the ratchet and ſcrew at reſt till the piece (t) ſtrikes on the end of the piece (p): the number of revolutions

Fig. 1. of the ſcrew at each tread is limited by the number of revolutions the cylinder is allowed to turn back before the ſtop ſtrikes on the piece (p).

"When the endleſs ſcrew was moved round its axis with a conſiderable velocity, it would continue that motion a little after the cylinder S was ſtopped: to

Fig. 1. & 4. prevent this, the angular lever was made; that when the lever J comes near to ſtop the ſcrew (x), it, by a ſmall chamfer, preſſes down the piece of the angular lever; this brings the other end of the ſame lever forwards, and ſtops the endleſs ſcrew by the ſteel pin ſtriking upon the top of it: the foot of the lever is raiſed again by a ſmall ſpring preſſing on the brace (v).

"D, two clamps, connected by the piece , ſlide

Fig. 1, 2, 6. one on each arm of the frame L, and may be fixed at pleaſure by the four finger-ſcrews, which preſs againſt ſteel ſprings to avoid ſpoiling the arms: the piece (q) is made to turn without ſhake between two conical pointed ſcrews (f), which are prevented from unturning by tightening the finger-nuts N. Ramſden's Machine.

"The piece M is made to turn on the piece (q), by Fig. 6. the conical pointed ſcrews (f) reſting in the hollow centers (e).

"As there is frequent occaſion to cut diviſions on inclined planes, for that purpoſe the piece , in which the tracer is fixed, has a conical axis at each end, which turn in half holes: when the tracer is ſet to any inclination, it may be fixed there by tightening the ſteel ſcrews .

Deſcription of the Engine by which the endleſs ſcrew of the Dividing Engine was cut.

"Fig. 9. repreſents this engine of its full dimenſions ſeen from one ſide.

"Fig. 8. the upper ſide of the ſame as ſeen from above.

"A repreſents a triangular bar of ſteel, to which the triangular holes in the pieces B and C are accurately fitted, and may be fixed on any part of the bar by the ſcrews D.

"E is a piece of ſteel whereon the ſcrew is intended to be cut; which, after being hardened and tempered, has its pivots turned in the form of two fruſtums of cones, as repreſented in the drawings of the dividing engine (fig. 5.). Theſe pivots were exactly fitted to the half holes F and T, which were kept together by the ſcrews Z.

"H repreſents a ſcrew of untempered ſteel, having a pivot I, which turns in the hole K. At the other end of the ſcrew is a hollow centre, which receives the hardened conical point of the ſteel pin M. When this point is ſufficiently preſſed againſt the ſcrew, to prevent its ſhaking, the ſteel pin may be fixed by tightening the ſcrews Y.

"N is a cylindric nut, moveable on the ſcrew H; which, to prevent any ſhake, may be tightened by the ſcrews O. This nut is connected with the ſaddle-piece P by means of the intermediate univerſal joint W, through which the arbor of the ſcrew H paſſes. A front view of this piece, with a ſection acroſs the ſcrew arbor, is repreſented at X. This joint is connected with the nut by means of two ſteel ſlips S, which turn on pins between the cheeks T on the nut N. The other ends of theſe ſlips S turn in like manner on pins (a). One axis of this joint turns in a hole in the cock (b), which is fixed to the ſaddle-piece; and the other turns in a hole (d), made for that purpoſe in the ſame piece on which the cock (b) is fixed. By this means, when the ſcrew is turned round, the ſaddle-piece will ſlide uniformly along the triangular bar A.

"K is a ſmall triangular bar of well-tempered ſteel, which ſlides in a groove of the ſame form on the ſaddle-piece P. The point of this bar or cutter is formed to the ſhape of the thread intended to be cut on the endleſs ſcrew. When the cutter is ſet to take proper hold of the intended ſcrew, it may be fixed by tightening the ſcrew (e), which preſs the two pieces of braſs G upon it.

"Having meaſured the circumference of the dividing-wheel, I found it would require a ſcrew about one thread

Ramſey. thread in a hundred coarſer than the guide-ſcrew H. The wheels on the guide-ſcrew arbor H, and that on the ſteel E, on which the ſcrew was to be cut, were proportioned to each other to produce that effect, by giving the wheel L 198 teeth, and the wheel Q 200. Theſe wheels communicated with each other by means of the intermediate wheel R, which alſo ſerved to give the threads on the two ſcrews the ſame direction.

"The ſaddle-piece P is confined on the bar A by means of the pieces (g), and may be made to ſlide with a proper degree of tightneſs by the ſcrews (n)."

For Ramſden's equatorial or portable obſervatory, ſee Optics, n° 102. and Astronomy, n° 504. See alſo a long account of an equatorial inſtrument made by Mr Ramſden by the direction of Sir George Shuckburgh in the Philoſophical Tranſactions for 1793, art. x. p. 67. In this inſtrument the circle of declinations is four feet in diameter, and may be obſerved nearly to a ſecond. The glaſs is placed between ſix pillars, which form the axis of the machine, and turn round by two pivots placed on two blocks of ſtone. See alſo Barometer.

RAMSEY, a town of Huntingdonſhire, 68 miles north of London, and 12 north-eaſt of Huntingdon. It is ſituated as it were in an iſland, being everywhere encompaſſed with fens, except on the weſt, where it is ſeparated from the *terra firma* by a cauſey for two miles. The neighbouring meers of Ramſey and Whitleſey, which are formed by the river Nyne, abound with fowl and fiſh, eſpecially eel and large pikes. It was once famous for a very rich abbey, part of the gatehouſe of which is ſtill ſtanding, and a neglected ſtatue of Ailwin; the epitaph of whoſe tomb, which is reckoned one of the oldeſt pieces of Engliſh ſculpture extant, ſtyles him "kinſman of the famous King Edward, alderman of all England, and the miraculous founder of this abbey." It was dedicated to St Dunſtan, and its abbots were mitred, and ſat in parliament; and ſo many kings of England were benefactors to it, that its yearly rents, ſays Camden, were 7000l. The town was then called *Ramſey the Rich*; but by the diſſolution of the abbey it ſoon became poor, and even loſt its market for many years, till about 185 years ago it recovered it. It is held on Saturday, and is reckoned one of the moſt plentiful and cheapeſt in England. In the year 1721 a great number of Roman coins was found here, ſuppoſed to have been hid by the monks on ſome incurſion of the Danes. There is a charity ſchool in the town for poor girls. W. Long. 0. 19. N. Lat. 52. 26.

Ramsey, an iſland of ſouth Wales, on the coaſt of Pembrokeſhire, about two miles in length, and a mile and a half broad. Near it are ſeveral ſmall ones, known by the name of the *biſhop and his clerks*. It is four miles weſt of St David's, and 17 north-weſt of Milford haven. It belongs to the biſhopric of St David's, and was in the laſt age, ſays Camden, famous for the death of one Juſtinian, a moſt holy man, who retiring hither from Britanny, in that age rich in ſaints, and devoting himſelf entirely to God, lived a long while in ſolitude, and being at laſt murdered by his ſervant was enrolled among the martyrs. W. Long. 5. 20. N. Lat. 51. 55.

Ramsey, in the Iſle of Man, to the north, a moſt noted and ſpacious haven, in which the greateſt fleet may ride at anchor with ſafety enough from all winds but the north-eaſt, and in that caſe they need not be embayed. This town ſtanding upon a beach of looſe ſand, or ſhingle, is in danger, if not timely prevented, of being waſhed away by the ſea. Ramſgate ſi Ramus.

RAMSGATE, a ſea-port town of Kent, in the iſle of Thanet, five miles from Margate, where a very fine pier has been lately built for the ſecurity of ſhips that come into the harbour, being ſeated near the Downs, between the north and ſouth Foreland, 10 miles north-eaſt of Canterbury. The town is ſituated in the cove of a chalky cliff. It was formerly but an obſcure fiſhing village, but ſince the year 1688 has been improved and enlarged by a ſucceſsful trade to Ruſſia and the eaſt country. But what renders it moſt worthy of notice, and attracts multitudes of ſtrangers, is the new harbour, which is one of the moſt capacious in England, if not in Europe. It was begun in the year 1750, but delayed by various interruptions. It conſiſts of two piers; that to the eaſt is built wholly of Purbeck ſtone, and extends itſelf into the ocean near 800 feet before it forms an angle; its breadth on the top is 26 feet, including a ſtrong parapet wall, which runs along the outſide of it. The other to the weſt is conſtructed of wood as far as the low-water mark, but the reſt is of ſtone. The angles, of which there are five in each pier, conſiſt of 160 feet each, with octagons at the end of 60 feet diameter, leaving an entrance of 200 feet into the harbour, the depth of which admits of a gradual increaſe of 18 to 36 feet. E. Long. 1. 30. N. Lat. 51. 22.

RAMTRUT, a deity worſhipped by the Ranazins of Hindoſtan, where he has a celebrated temple at Onor. He is repreſented as more reſembling a monkey than a man.

RAMUS, in general, denotes a branch of any thing, as of a tree, an artery, &c. In the anatomy of plants it means the firſt or lateral branches, which go off from the petiolum, or middle rib of a leaf. The ſubdiviſions of theſe are called *ſurculi*; and the final diviſions into the moſt minute of all, are by ſome called *capillamenta*; but both kinds are generally denominated *ſurculus*.

Ramus (Peter), was one of the moſt famous profeſſors of the 16th century. He was born in Picardy in 1515. A thirſt for learning prompted him to go to Paris when very young, and he was admitted a ſervant in the college of Navarre. Spending the day in waiting on his maſters, and the greateſt part of the night in ſtudy, he made ſuch ſurpriſing progreſs, that, when he took his maſter of arts degree, he offered to maintain a quite oppoſite doctrine to that of Ariſtotle. This raiſed him many enemies; and the two firſt books he publiſhed, *Inſtitutiones Dialecticæ*, and *Ariſtotelicæ Animadverſiones*, occaſioned great diſturbances in the univerſity of Paris: and the oppoſition againſt him was not a little heightened by his deſerting the Romiſh religion, and profeſſing that of the Reformed. Being thus forced to retire from Paris, he viſited the univerſities of Germany, and received great honours wherever he came. He returned to France in 1571, and loſt his life miſerably in the horrid maſſacre of St Bartholomew's day. He was a great orator, a man of univerſal learning, and endowed with very fine moral qualities.

Ramus

ties. He publiſhed many books, which Teiſſier enumerates. Ramus's merit in his oppoſition to Ariſtotle, and his firmneſs in undermining his authority, is unqueſtionably great. But it has been doubted, and with much reaſon, whether he was equally ſucceſsful in his attempts after a new logical inſtitute. We have the following general outline of his plan in Dr Enfield's Hiſtory of Philoſophy. "Conſidering dialectics as the art of deducing concluſions from premiſes, he endeavours to improve this art, by uniting it with that of rhetoric. Of the ſeveral branches of rhetoric, he conſiders invention and diſpoſition as belonging equally to logic. Making Cicero his chief guide, he divides his treatiſe on dialectics into two parts, the firſt of which treats of the invention of arguments, the ſecond of judgments. Arguments he derives not only from what the Ariſtotelians call middle terms, but from any kind of propoſition, which, connected with another, may ſerve to prove any aſſertion. Of theſe he enumerates various kinds. Judgments he divides into axioms, or ſelf-evident propoſitions, and *dianoëa*, or deductions by means of a ſeries of arguments. Both theſe he divides into various claſſes; and illuſtrates the whole by examples from the ancient orators and poets.

"In the logic of Ramus, many things are borrowed from Ariſtotle, and only appear under new names; and many others are derived from other Grecian ſources, particularly from the dialogues of Plato, and the logic of the Stoics. The author has the merit of turning the art of reaſoning from the futile ſpeculations of the ſchools to forenſic and common uſe; but his plan is defective in confining the whole dialectic art to the ſingle object of diſputation, and in omitting many things, which reſpect the general culture of the underſtanding and the inveſtigation of truth. Notwithſtanding the defects of his ſyſtem, we cannot, however, ſubſcribe to the ſevere cenſure which has been paſſed upon Ramus by Lord Bacon and others; for much is, we think, due to him for having with ſo much firmneſs and perſeverance aſſerted the natural freedom of the human underſtanding. The logic of Ramus obtained great authority in the ſchools of Germany, Great Britain, Holland, and France; and long and violent conteſts aroſe between his followers and thoſe of the Stagyrite, till his fame vaniſhed before that of Deſcartes."

Ran.

RAN, in the old Engliſh writers, means open or public robbery, ſo manifeſt as not to be denied. Ran *dicitur aperta rapina quæ negari non poteſt.* Lamb. 125. Leg. Canut. cap. 58. Hence it is now commonly ſaid of one who takes the goods of another injuriouſly and violently, that he has taken or ſnatched all he could *rap* and *ran*.

RANA, or RANULA. See RANULA.

END OF THE FIFTEENTH VOLUME.

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Encyclopaedia britannica or a dictionary of arts, sciences and miscellaneous litterature

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